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Movement Patterns of Green Turtles (*Chelonia mydas*) in Cuba and Adjacent Caribbean Waters Inferred from Flipper Tag Recaptures

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Abstract.—**To study the movement patterns of Green Seaturtle (*Chelonia mydas*) populations in the Caribbean region using Cuban habitats, tag-recapture data from local (Cuban National Tagging Program 1989–2002) and international programs (1959–2002) were compiled and compared. Of the 742 turtles tagged in Cuba at fishing areas, nesting beaches and head-start facilities, 5.5% were recaptured, mostly outside of Cuban waters and with a majority of these (76.9%) off the coast of Nicaragua. Green Seaturtles tagged elsewhere and recaptured in Cuba included head-started juveniles from Grand Cayman (45% of the total), Mexico (2.3%), and Florida (1.8%); wild juveniles from the Bahamas (14.1%), Bermuda (5.4%), and Florida (1.5%); and adults from Tortuguero (26%), Florida, USA (1.3%), Mexico (1%), Venezuela (1.3%), and U.S. Virgin Islands (0.3%). Recaptures of tags placed at sites north of Cuba (Bermuda and the Bahamas) clustered in the northeast region of Cuba, whereas those from the south (Grand Cayman) were recaptured in southern areas. Recaptures from Tortuguero tags were concentrated in the southeast and westward regions of Cuba. Turtles from the Bahamas, Grand Cayman, and Bermuda showed the highest recapture rates in Cuban habitats, with 3.2, 1.9, and 1.0% of the total number of tags applied, respectively. These results for a broad range of populations and across life stages underscore the regionwide significance of Cuban sites as critical habitats or migratory corridors.**

As with most marine turtles, the life history of the Green Seaturtle (*Chelonia mydas*) includes extensive migrations of hundreds or thousands of kilometers carrying them through different developmental habitats (Meylan and Meylan, 1997) and, as adults, between feeding and reproductive areas (Carr et al., 1978). Because of the vast expanses of sea that are involved, movements are difficult to monitor. Techniques to study migration have been based largely on tag-recapture programs (Carr et al., 1978; Balazs, 1983; Mortimer and Carr, 1987; Limpus et al., 1992) and, more recently, on new technology, such as satellite tracking and genetic analyses that allow precise tracking of turtles along migratory corridors over discrete periods (Balazs et al., 1994; Liew et al., 1995; Luschi et al., 1998) or

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estimates of the contributions by different populations to mixed stocks at foraging grounds (Bass et al., 1998; Lahanas et al., 1998; Bass and Witzell, 2000).

Within the Greater Caribbean, the Cuban shelf offers optimal conditions for the various life stages of marine turtles and hosts habitats for five of the region's six species (Carrillo and Moncada, 1998). For example, Green Seaturtle nesting populations with a significant degree of genetic differentiation from others in the region (Espinosa et al., 1999), nest at prime areas in the Península de Guanahacabibes (with more than 400 nests per year; Ibarra et al., 2002) as well as in the Archipiélagos de los Jardines de la Reina and de los Canarreos (Moncada and Nodarse, 1998; Nodarse et al., 2000). In the latter area alone, more than 1000 nests have been reported during 2002–2003 at Cayo Largo del Sur (Nodarse et al., in press). Further, Cuba's shallow shelf and extensive seagrass beds (Buesa, 1974) provide ideal foraging areas that draw individuals from a number of the region's Green Seaturtle stocks as evidenced by preliminary tagging results (Moncada, 1992; Moncada et al., 1996, 2002).

Despite developments in the methods used to study migrations and the large number of studies focusing on Green Seaturtles in the Caribbean, critical gaps persist that can be addressed using traditional flipper tagging studies particularly when integrating results from regionwide efforts. This paper is the first to compile information from tagging programs throughout the Caribbean Region in an effort to determine movement patterns of Green Seaturtles to and from Cuban waters. In addition to migratory pathways, we provide data on speeds and distances traveled by tagged turtles.

Materials and Methods

Tag and recapture data for this study derive from two sources: the Cuban National Tagging Program (CNTP), run by the Fisheries Research Center of Cuba (1989–2002), and from turtles tagged in other countries (1959–2002) and recaptured in the Cuban turtle fisheries or in by-catch from other fisheries and sent either through the CNTP or directly to the source tagging programs. Tagging of Green Seaturtles for the CNTP took place within the fishing area of Cuban shelf, during the closed season (May to July): Nuevitas (Punta de Ganado), Las Tunas (Morrillo, Herradura, Cobarrubias, and Palancón) both in the northeast region; Cayos de las Doce Leguas (southeast region), and at Isla de la Juventud (southwest region); using traditional fishing nets (see Carrillo et al., 1998). Females were also tagged at nesting beaches: Isla de la Juventud (Guanal, southwest region) during or after eggs had been laid. Inoxidizable steel Monel tags, inscribed with a legend "Award, return MIP, Barlovento, Sta Fé" followed by a prefix (C or CU) and a unique number were applied to the trailing edge of front flippers.

We measured the straight and curved carapace lengths of tagged animals from the leading edge of the nuchal (precentral) scute to the trailing edge of the marginal scutes (SCLn-t and CCLn-t, to be consistent with Bolten, 1999). When possible, we recorded sex, taking into account the size of the animal and the development of secondary sexual characteristics (length of the tail and presence or absence of claws on the front flippers). All individuals without secondary sexual characteristics and lengths below the mean nesting size were classified as "juveniles" or immature (imm. in Appendix 1).

We estimated minimal distances traveled between tagging and recapture (in kilometers) using Map Source Software V.3.02 (GPS; Garmin, 1999). We then estimated average speed by dividing distance traveled by time elapsed (in days). We did not estimate speed for turtles recaptured after periods of >1 yr because of the increasing possibility that these individuals could have remained at the recapture or intermediate sites for extended periods or have carried out additional unrecorded movements before recapture. To compare the time and distance between recaptures between immature and adult turtles, we used a Mann-Whitney *U*-test because the data were not normally distributed.

Data from tags applied in foreign areas and recaptured in Cuba were not always complete. Tags used for this study contained at least tagging location, as well as, information on tagging date and life stage of turtles at the time of tagging. We estimated rates of recaptures in Cuban habitats for each tagging origin as the percent of the total number of tags applied at the tagging site that were recaptured in Cuban habitats. These recapture rates are an estimate of the tendency of turtles to travel to Cuban habitats (Appendix 2). Although this index proved useful for our comparisons, we recognize that variation in effort and the quality of tagging across tagging programs could impact recapture probabilities. Because the total number of tags placed in specific populations was not always available, we could not calculate this measure for all tagging origins found in this study.

Homogeneity of development stages and recaptures of geographic distribution by each tagging origin among the four study regions (NE, NW, SE, SW; Fig. 1) of Cuba was tested by Chi-square analysis, using the program CHIRXC (Zaykin and Pudovkin, 1993), which generates probabilities using a Monte Carlo randomization procedure. Means are given $\pm$ 1 SD.

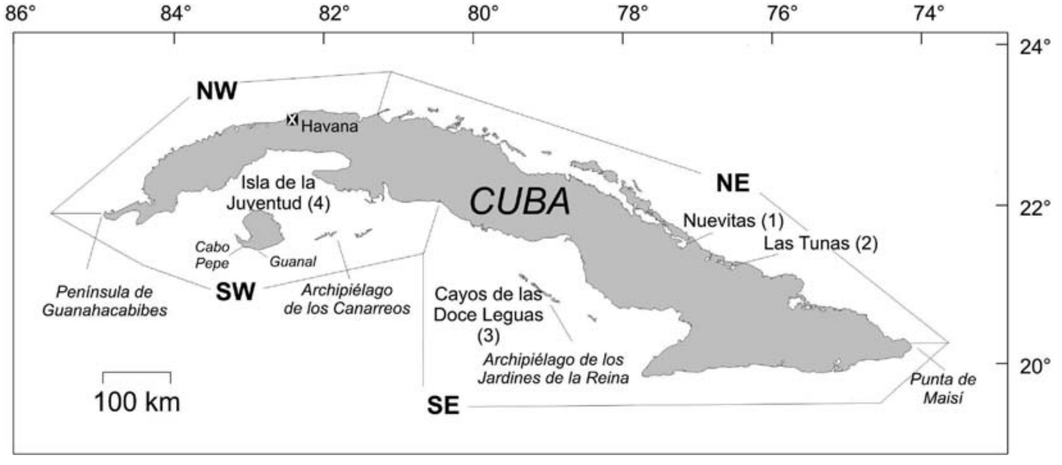

FIG. 1. Localities within the four fishing zones (NW, NE, SE, SW) in Cuba where Green Turtles were tagged. Main Green Turtle nesting regions (Península de Guanahacabibes, and Archipiélagos de los Jardines de la Reina and Canarreos) are also shown.

RESULTS

Cuban Tag-Recapture Program.—A total of 742 turtles was flipper-tagged in Cuba. Of these, the largest percentage of tags was applied at traditional fishing sites during live capture and release and on predominantly juvenile turtles with a size distribution reflecting the typical composition in habitats in the northeast (N = 553; CCL range = 30–129 cm, mean = 83.9 ± 10.3, mode = 79 cm). Tags were applied to females nesting at the Guanal in Isla de la Juventud (N = 147; range = 85–124 cm, 103.8 ± 5.4, mode = 102 cm) and to head-started juveniles (N = 42) from Isla de la Juventud (Fig. 2A,B).

Of the 41 turtles recaptured (5.5% of the total; Appendix 1), nine were adults (seven females,

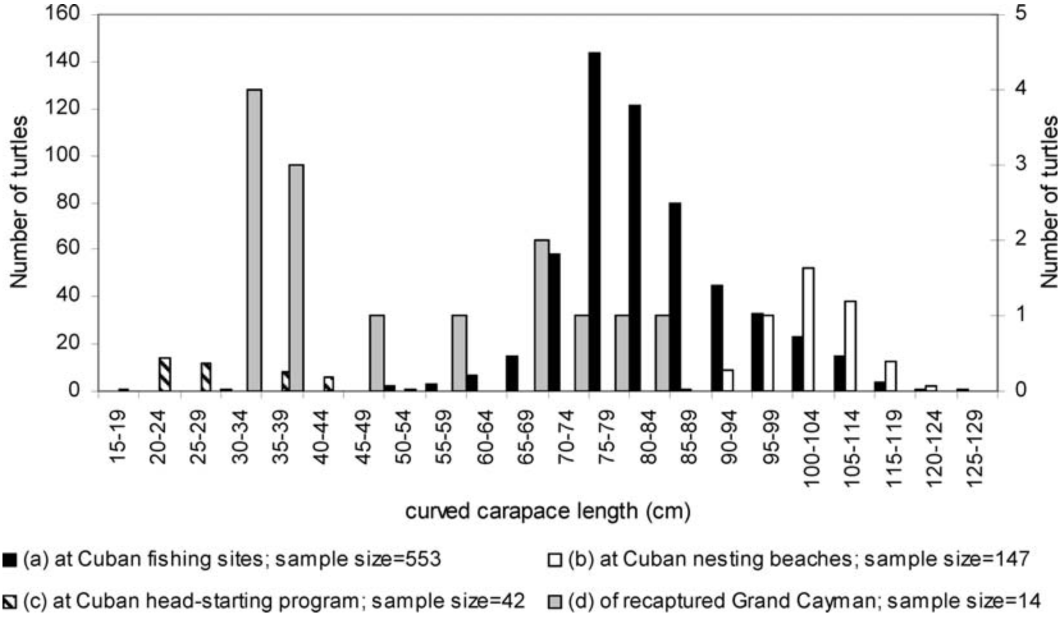

FIG. 2. Size distribution (cm CCL) of Green Seaturtles used in the tag-recapture studies. (A) Sizes at tagging of turtles caught at fishing areas in the northeast; (B) sizes at tagging of nesting females caught at the Guanal; (C) sizes at tagging of turtles released from the Isla de la Juventud head-start rearing program; (D) Sizes at recapture of Grand Cayman turtles reared in a head start-facility.

TABLE 1. Distribution of Green Seaturtle recaptures in Cuba's four study zones (Fig. 1) by origin of tagging and life stage. A = adult nesting females and subadults; J = juveniles; H = head-started; W = wild-reared; U = recapture zone not known; NA = not analyzed because of small sample sizes. Details of recaptures are available upon request from the authors. Origins with statistically equivalent ($P > 0.05$) geographic distribution of recaptures in Cuba in homogeneity tests are denoted with the same superscript. Geographic distribution of recaptures from Florida and Quintana Roo tagging were not found to be significantly different ($P > 0.05$) and, therefore, grouped for homogeneity tests. Number of recaptures from Isla Aves and U.S. Virgin Islands were too few for statistical analysis.

Origin of tagging	Life stage	Recaptures in each zone in Cuba				*U*	Totals	Recaptures (%)
		NW	NE	SW	SE			
Bermuda[a,b]	WJ	1	17	1	2		21	5.4
Central Bahamas[a]	WJ	3	24	0	0	0	27	6.9
Inagua, Bahamas[b]	WJ	3	18	1	4	2	28	7.2
Grand Cayman[c]	HJ	6	16	28	113	13	176	45.0
Tortuguero, Costa Rica[d]	A	33	5	18	40	6	102	26.1
Florida	HJ	2	1	0	4	0	7	1.8
(various programs),	WJ	1	4	0	0	1	6	1.5
USA[e]	A	2	2	1	0	0	5	1.3
Quintana Roo,	HJ	4	1	2	2	0	9	2.3
México[e]	A	2	1	0	0	1	4	1.0%
Isla Aves, Venezuela	A	0	1	0	1	3	5	1.3%
U.S. Virgin Islands	A	1	0	0	0	0	1	0.3%
Totals		58	90	51	166	26	391	100.0%

two males), 31 wild juveniles, and a single head-started juvenile. For all recaptured turtles, time between tagging and recapture of adults ($N = 9$; mean = 473 days) was not statistically significant different from that of wild juveniles ($N = 27$; mean = 1076 days; $U = 121$; $P = 0.1$); however, for the total distance traveled a statistically significant difference was observed (mean = 1000 and 2292 km, respectively; $U = 106.5$; $P = 0.023$).

Sixteen tagged turtles were recaptured inside the Cuban shelf within two to 1130 days after release (mean = 140 days), and 25 were recaptured in waters of other countries in the region between 123 and 3785 days after release (mean = 1629; see Appendix 1). Recaptures from Nuevitas and Las Tunas included both wild juvenile and adult turtles (26 and three for the former; five and two for the latter), and, at least for this region, the majority of the turtles (69%; 23 wild juveniles and two adults) were recaptured in foreign waters and not within Cuba (31%; eight wild juveniles and three adults), although the difference was not significant ($\chi^2 = 2.37$; $P = 0.31$). The majority of foreign recaptures, both for adult and wild juvenile turtles, were found off Nicaragua (50% and 84% of the totals, respectively), followed by Costa Rica for adults (50%) and United States, Panama, Honduras, and Costa Rica for wild juveniles (4% each of the total). Of the turtles tagged in Nuevitas and Las Tunas, which were recaptured within Cuba, the majority were recaptured within the northeast (83%; two adults and eight juveniles), whereas the rest (17%; one adult, and one juvenile) were later found at sites on the opposite side of Cuba. Although small sample sizes and absence of the various developmental stages preclude a rigorous analysis for Isla de la Juventud turtles, all four females tagged there were recaptured within Cuban waters.

Mean minimum distances traveled per day for turtles recaptured less than 365 days after release fluctuated between 0.5 and 1 km d^{-1} for the three nesting females from Isla de la Juventud, 1.3–25.6 km d^{-1} for wild juveniles ($N = 10.3 \pm 6.9$ km d^{-1}) and 9.7–23.9 km d^{-1} ($N = 3$, 18.4 ± 6.4 km d^{-1}) for adults.

Direction of travel could be inferred from recaptured turtles. Three adults and six juveniles tagged in the northeast were recaptured at localities east of the initial tagging site (Appendix 1); within the Cuban shelf.

Turtles Tagged outside of Cuba.—Of the Green Seaturtles tagged in the region and recaptured in Cuban waters, 144 were obtained through the CNTP and 247 by local fishers with the data sent directly to tagging programs.

Turtles tagged in foreign areas were recaptured across all of Cuba's coastal zones (Fig. 1; Table 1). Most of these turtles had been tagged as wild juveniles or subadults, whereas all of the recaptured turtles tagged as juveniles in Grand Cayman and Mexico were reportedly reared in "head-start" programs. Juveniles tagged in Florida included both head-started and wild individuals.

There was a lack of homogeneity ($\chi^2 = 255.542$, $P < 0.0001$) of recaptures across the four coastal fishing zones in Cuba. Recaptures of turtles tagged at sites north of Cuba (Bermuda and Bahamas tags; Table 1) clustered on the northern coast of Cuba. However, recaptures of turtles tagged at sites south or west of Cuba clustered either in the southeast to southwest (Grand Cayman tags) or spread among sites from northwest to southeast (Tortuguero, Florida and Quintana Roo, Mexico tags).

Turtles tagged in the Bahamas, Grand Cayman, and Bermuda had the highest proportion of recaptures in Cuba with 3.2, 1.9, and 1.0% of the total number of tags applied (Appendix 2). In contrast, recaptures of Tortuguero turtles, in spite of being the second most abundant recaptured source in Cuba (26.1% of the total, second only to Grand Cayman) represented only 0.3% of recaptures in Cuba. Turtles tagged in Quintana Roo, Mexico represented 0.9% of recaptures in Cuba; all others represented less than 0.5% of recaptures in Cuba. Green Seaturtles in Campeche and Yucatán, states adjacent to Quintana Roo with nesting beaches within the Gulf of Mexico were not recaptured in Cuba, in spite of being subjected to similar tagging efforts (see Appendix 2).

Discussion

Cuban Tag-Recapture Program.—Although marine turtles can swim with or against currents (Meylan, 1982a,b) the tagged Green Seaturtles in the northeast region of Cuba moved from west to east consistent with the direction of prevailing currents along the north coast in the summer (García, 1990a,b). These observations, combined with the percentage of recaptures in foreign waters to the east or west of Cuba, suggest that the north coast of Cuba is a migratory corridor for turtles moving to destination habitats in the southern Cuban shelf or to coastal waters of other countries.

Movements of postnesting females, tagged at Isla de la Juventud, were also in the same direction as prevailing local currents (García, 1990a,b); however, in contrast to those from the northeast, they were recaptured within a relatively short distance of the nesting site. Moreover, the minimum estimated speeds of these turtles were much lower than other turtles, indicating that their movement patterns are part of internesting behavior (see Dizon and Balazs, 1982; Meylan, 1982a).

Minimum speeds estimated from non-nesting turtles tagged and recaptured within Cuban waters for both juvenile and adult turtles were on the lower end of the range of previously published studies of flipper-tagged, postnesting females (35–80 km d^{-1}, Schultz, 1975; 41.1 km d^{-1}, Mortimer and Carr, 1987; 10–39 km d^{-1}, Solé, 1994). However, recent satellite telemetry results have demonstrated that Green Seaturtles follow a biphasic migratory pattern with relatively high velocities and fairly direct movements when traveling across pelagic areas then slowing down and follow the coastline when reaching the neritic zone (e.g., Hays et al., 2002). Given this, our results are within the range observed for both juvenile and postnesting adults during their coastal tracks if constant speed is assumed (8.7–15.2 km d^{-1}, Kinzell, 2001; 14–43 km d^{-1}, Godley et al., 2002, 14–33 km d^{-1}, Hays et al., 2002; 2–24 km d^{-1}; Godley et al., 2003) and could indicate that the turtles in our study are participating in foraging activity and not merely in transit.

The speeds estimated from data of turtles recaptured within one-year of tagging and traveling to Nicaragua, Honduras, and the United States were all less than 25 km d^{-1} (Appendix 1), whether following straight-line displacement or following the Cuban coast and then crossing the Yucatan channel. The results may reflect local coastal behavior rather than oceanic movements since these speeds are very low compared to any of the published speeds for oceanic movements (e.g., Hays et al., 2002).

Turtles Flipper Tagged outside of Cuba.—Recapture of tagged animals originating from several Green Seaturtle populations outside of Cuba indicates that Cuban habitats are foraging habitats and/or migratory corridors, for both juveniles and adults. Recaptures of this species in practically all areas of the Cuban shelf may be the result of availability of foraging habitats. Local studies show that algal and seagrass pastures, often dominated by turtlegrass (*Thalassia testudinum*) and other algal species that are known food items for the Green Seaturtle (Hirth, 1997), are found in about 70% of the Cuban shelf and in high densities (> 1200 g m^{-2}; Buesa, 1974; Jiménez and Ibarzabal, 1982; Suárez and Cortes, 1983; Jiménez and Alcolado, 1990).

The spatial distribution of recaptures from different tagging origins (Table 1) does not appear random and likely reflects environmental and intrinsic factors that are important in determining ontogenetic shifts in habitat use (Musick and Limpus, 1997). Orientation, proximity of the original site, and oceanographic features may play major roles influencing the direction of travel when developmental needs trigger turtle movements among habitats. Turtle recaptures clustered primarily in the northeast are dominated by turtles tagged in Bermuda and the Bahamas, both Green Seaturtle developmental habitats (Bjorndal and Bolten, 1996; Meylan and Meylan, 1997) with recruitment of small (post-pelagic) juveniles (about 30–80 cm SCL; Meylan et al., 1992; Lahanas et al., 1998) originating in rookeries from throughout the Caribbean (Engstrom et al., 1998; Lahanas et al., 1998). The very high percentages of tags from these two tagging origins recaptured in Cuba (Appendix 2) and their clustering in the northeast region confirms their general and focused southward travel (in spite of their geographically diverse natal origins) and use of Cuban habitats as conduits towards other final destinations for further development or for extended residence. The predominant size of turtles in the northeast (75–79 cm CCL, see Fig. 2a) coincides with the general size of turtles emigrating from Bahamas and Bermuda (Meylan et al., 1992) to the developmental habitats and could indicate a significant influx of this size class to northeast region. Results for Bermuda tagged turtles support Cuba as the second most important international recapture site after Nicaragua (P. Meylan, A. Meylan and J. Gray; unpubl. data) and imply these turtles may be using Cuban habitats either as secondary developmental habitats or migratory routes before they move on to secondary developmental sites off Nicaragua.

The concentration of recaptures from the smaller size class turtles from Grand Cayman (Fig. 2d) in the southern Cuban regions (Table 1) probably results from the combination of proximity and favorable ocean currents that assist the transport of head-started juveniles from release sites toward developmental habitats along the southern Cuban coast (Bell et al., 2005). For this stock, the Cuban archipelago (mainly along the southern coast) serves as the main developmental habitats at least for the smaller size classes (30–85 cm CCL; Fig. 2d). Furthermore, as Cayman tags have been recovered in Nicaragua but after longer time periods, Nicaraguan habitats may represent secondary developmental habitats (C. Bell, unpubl. data), possibly after an initial phase in Cuba.

Relatively low proportions of Tortuguero-tagged adults were recaptured in Cuba (Appendix 2), when compared with other tagging origins. However, in spite of this stock representing the largest population in the region (more than 19,000 nesting females per year; Bjorndal et al., 1999) and contributing the highest numbers of tagged nesters (> 30,000 since 1980; S. Tröeng, unpubl. data; Appendix 2), the result reflects that the use of Cuban habitats by Tortuguero nesting females is secondary when compared with foraging in other regions of the Caribbean. Tortuguero nesting female recaptures in Cuba represent, by a slim margin, the second most abundant international recaptures (about 3% of total) but are dwarfed by nearly 90% of recaptures occurring in the Cayos Miskito off Nicaragua (S. Tröeng, unpubl. data) where turtle grass beds are more abundant and extensive than in other regions (Carr et al., 1978).

Management and Research Implications.—Although our results can only indicate movement patterns, there are general conclusions that coincide with recent studies on the demographic composition of Green Seaturtle foraging sites in the Caribbean using molecular markers (e.g., Bass et al., 1998; Lahanas et al., 1998; Bass and Witzell, 2000). One such conclusion is that long-distance movements by both adult and juvenile Green Seaturtles from various countries converge on Cuban habitats. These results underscore the practical value of flipper tagging as an indispensable complement to other tools, such as genetic analyses and satellite tracking. The downside, unfortunately, is that more than 30 years of tagging have been needed to obtain meaningful results. Moreover, extensive collaboration between international tagging programs is still required to achieve compilation of extensive regional databases that remain underused.

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APPENDIX 1. Information for 41 green turtles tagged in Cuba and recaptured in waters of this and other countries in the period 1989–2002. M = males, F = females, imm = juvenile/subadult, H = head-started. See methodology section for procedure used to estimate average speeds. CCL represents measurements at tagging.

Tag no.	CCL at tagging (cm)	Dev stage	Tagging date	Latitude	Longitude	Tagging site	Country	Tagging contact email	Recapture date
CU0302	79	imm	5/3/89	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@ cip.telemar.cu	05/07/1989
C3111	97	M	5/15/90	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@ cip.telemar.cu	5/17/90
C3356	85	imm	6/28/91	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@ cip.telemar.cu	1/20/92
CU0933	83	imm	5/4/02	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@ cip.telemar.cu	9/4/02
C3226	105	F	6/1/90	21°21′20.1″	76°39′25.5″	Cobarrubias, Las Tunas	Cuba	fmoncada@ cip.telemar.cu	7/11/90
C3266	91	imm	7/1/90	21°21′20.1″	76°39′25.5″	Cobarrubias, Las Tunas	Cuba	fmoncada@ cip.telemar.cu	11/12/90
CU0408	102	F	19/05/1989	21°25′8.3″	76°50′16.5″	Palancon, Las Tunas	Cuba	fmoncada@ cip.telemar.cu	6/16/89
CU0013	110	F	7/3/89	21°27′07.0″	82°48′33.0″	Guanal, I. Juventud	Cuba	fmoncada@ cip.telemar.cu	8/9/89
CU0015	93	F	7/4/89	21°27′07.0″	82°48′33.0″	Guanal, I. Juventud	Cuba	fmoncada@ cip.telemar.cu	04/08/1989
CU0038	110	F	11/07/1990	21°27′07.0″	82°48′33.0″	Guanal, I. Juventud	Cuba	fmoncada@ cip.telemar.cu	8/1/90
CU0304	81	imm	5/6/89	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@ cip.telemar.cu	5/14/89
CU0324	72	imm	5/21/89	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@ cip.telemar. cu	1/27/90
CU0338	75	imm	6/4/89	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@ cip.telemar.cu	6/15/89
CU0356	72	imm	6/14/89	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@ cip.telemar.cu	7/6/89
C3178	77	imm	6/18/90	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@ cip.telemar.cu	6/22/92
CU0416*	79	imm	5/29/89	21°25′8.3″	76°50′16.5″	Palancon, Las Tunas	Cuba	fmoncada@ cip.telemar.cu	6/1/89
CU0416*	79	imm	6/1/89	21°21′20.1″	76°39′25.5″	Cobarrubias, Las Tunas	Cuba	fmoncada@ cip.telemar.cu	6/20/89
C4500	53	H-imm	10/21/97	21°29′23.7″	83°5′40.1″	A. Holl, I. Juventud	Cuba	fmoncada@ cip.telemar.cu	5/2/98
C3126	96	M	5/21/90	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@ cip.telemar.cu	10/21/95
C3289	92	imm	5/29/91	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@ cip.telemar.cu	7/31/97
C3299	81	imm	5/29/91	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@ cip.telemar.cu	11/6/00
C3323	86	imm	6/14/91	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@ cip.telemar.cu	9/11/95
C3380	104	F	5/25/92	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@ cip.telemar.cu	6/1/96
C3398	85	imm	6/16/92	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@ cip.telemar.cu	1/29/00
C4303	83	imm	6/19/92	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@ cip.telemar.cu	not specif.
CU0963	80	imm	5/25/97	21°31′12.79″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@ cip.telemar.cu	12/9/01
CU0029	106	F	7/20/90	21°27′07.0″	82°48′33.0″	Guanal, I. Juventud	Cuba	fmoncada@ cip.telemar.cu	5/1/92
CU1623*	91	imm	3/27/93	21°16′47.6″	76°24′30.5″	Herradura, Las Tunas	Cuba	fmoncada@ cip.telemar.cu	not specif.
CU1623*		imm		10°31′24.1″	83°29′8.6″	P. Tortuguero	C Rica	sebastian@ cccturtle.org	10/27/00
C1603	82	imm	5/13/93	21°16′47.6″	76°24′30.5″	Herradura, Las Tunas	Cuba	fmoncada@ cip.telemar.cu	10/30/96
CU0355	63	imm	6/14/89	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@ cip.telemar.cu	11/1/97
CU0364	72	imm	6/21/89	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@ cip.telemar.cu	not specif.

APPENDIX 1. Extended.

Latitude	Longitude	Recapture locality	Country	Time period (days)	Dist travelled (approx.) (km)(C)	Overall average speed (km/d)(C)	Dist travelled (approx.) (km)(A)	Overall average speed (km/d)(A)	Recapture contact email
20°13′11.3″	74°8′4.7″	Sur Punta de Maisi	Cuba	63	338	5.36			fmoncada@ cip.telemar.cu
21°21′20.1″	76°39′25.5″	Cobarrubias, Las Tunas	Cuba	2	40	20.00			fmoncada@ cip.telemar.cu
15°53′36″	85°13′22″	Iriona Viejo, Colon	Honduras	206	2,930	14.20	1,665	8.08	Pastor Suazo Mejia
12°39′59″	83°22′39.2″	Tom shoal	Nicaragua	123	3,157	25.66	1,525	12.40	clagueux@ wcs.org
21°6′41.5″	79°25′23.2″	Breton, Cayos D. Leguas	Cuba	40	920	23.88			fmoncada@ cip.telemar.cu
21°28′2.4″	83°4′17.9″	Cabo Pepe, I. Juventud	Cuba	134	1,299	9.70			fmoncada@ cip.telemar.cu
20°13′11.3″	74°8′4.7″	Sur Punta de Maisi	Cuba	27	309	11.44			fmoncada@ cip.telemar.cu
21°28′2.4″	83°4′17.9″	Cabo Pepe, I. Juventud	Cuba	37	20	0.54			fmoncada@ cip.telemar.cu
21°28′2.4″	83°4′17.9″	Cabo Pepe, I. Juventud	Cuba	31	20	0.65			fmoncada@ cip.telemar.cu
21°28′2.4″	83°4′17.9″	Cabo Pepe, I. Juventud	Cuba	20	20	1.00			fmoncada@ cip.telemar.cu
21°21′20.1″	76°39′25.5″	Cobarrubias, Las Tunas	Cuba	8	40	5.00			fmoncada@ cip.telemar.cu
24°54′49″	80°39′0″	Florida, Matecumbe key	E. U	251	2,197	8.75	530	2.11	Barbara. Schroeder@ noaa.gov
21°21′20.1″	76°39′25.5″	Cobarrubias, Las Tunas	Cuba	11	40	3.64			fmoncada@ cip.telemar.cu
20°13′11.3″	74°8′4.7″	Sur Pta. Maisi	Cuba	22	338	15.36			fmoncada@ cip.telemar.cu
21°21′20.1″	76°39′25.5″	Cobarrubias, Las Tunas	Cuba	4	40	10.00			fmoncada@ cip.telemar.cu
21°21′20.1″	76°39′25.5″	Cobarrubias, Las Tunas	Cuba	3	4	1.33			fmoncada@ cip.telemar.cu
20°21′6.0″	74°28′8.2″	Norte Baracoa	Cuba	19	267	14.05			fmoncada@ cip.telemar.cu
21°30′44.7″	83°6′34.7″	Caleta	Cuba	192	22	0.10			fmoncada@ cip.telemar.cu
14°19′90″	82°42′77″	Cayos Miskitos	Nicaragua	1,979	2,955		1,500		clagueux@ wcs.org
10°31′24.1″	83°29′8.6″	Playa Tortuguero	Costa Rica	2,255	3,401		1,945		sebastian@ cccturtle.org
12°39′59″	83°22′39.2″	Tom Shoal	Nicaragua	465	3,157		1,525		clagueux@ wcs.org
12°56′11.19″	83°17′34.09″	Cayo Clar	Nicaragua	1,550	3,121		1,710		clagueux@ wcs.org
10°31′24.1″	83°29′8.6″	Playa Tortugaero	Costa Rica	1,468	3,401		1,945		sebastian@ cccturtle.org
14°19′90″	82°42′77″	Cayos Miskitos	Nicaragua	2,783	2,955		1,500		clagueux@ wcs.org
			Nicaragua						clagueux@ wcs.org
14°19′90″	82°42′77″	Cayo Miskito	Nicaragua	1,659	2,955		1,500		clagueux@ wcs.org
21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	651	1,318				fmoncada@ cip.telemar.cu
10°31′24.1″	83°29′8.6″	Playa Tortuguero	Costa Rica		3,340				sebastian@ cccturtle.org
17°19′1″	82°51′38.4″	Leimarka	Nicaragua		422				clagueux@ wcs.org
21°8′4.3″	76°7′48.3″	Gibara	Cuba	1,130	40				fmoncada@ cip.telemar.cu
12°56′11.19″	83°17′34.09″	Cayo Clar	Nicaragua	3,062	3,121		1,710		clagueux@ wcs.org
			Nicaragua						clagueux@ wcs.org

APPENDIX 1. Continued.

Tag no.	CCL at tagging (cm)	Dev stage	Tagging date	Latitude	Longitude	Tagging site	Country	Tagging contact email	Recapture date
CU0409	79	imm	5/22/89	21°25′8.3″	76°50′16.5″	Palancon, Las Tunas	Cuba	fmoncada@cip.telemar.cu	9/1/94
C3150	77	imm	6/1/90	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@cip.telemar.cu	9/1/94
C3165	75	imm	6/10/90	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@cip.telemar.cu	3/1/94
C3173	71	imm	6/13/90	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@cip.telemar.cu	1/1/92
C3199	77	imm	6/27/90	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@cip.telemar.cu	11/6/00
C3298	74	imm	5/29/91	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@cip.telemar.cu	not specif.
C3301	74	imm	5/30/91	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@cip.telemar.cu	01/06/1994
C3307	75	imm	6/2/91	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@cip.telemar.cu	9/20/98
C3332	73	imm	6/18/91	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@cip.telemar.cu	4/1/95
C3363	73	imm	6/30/91	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@cip.telemar.cu	7/24/93
CU0962	68	imm	5/25/97	21°31′12.8″	76°59′39.2″	P. Ganado, Nuevitas	Cuba	fmoncada@cip.telemar.cu	8/23/99

APPENDIX 1. Extended.

Latitude	Longitude	Recapture locality	Country	Time period (days)	Dist travelled (approx.) (km)(C)	Overall average speed (km/d)(C)	Dist travelled (approx.) (km)(A)	Overall average speed (km/d)(A)	Recapture contact email
14°19′90″	82°42′77″	Cayos Miskitos	Nicaragua	1,561	2,935		1,496		clagueux@wcs.org
			Nicaragua	1,553	2,955				clagueux@wcs.org
13°41′59″	83°30′38″	Houlever	Nicaragua	1,360	3,097		1,590		clagueux@wcs.org
12°44′24″	83°22′45″	Cayo King	Nicaragua	567	3,113		1,720		kab@zoo.ufl.edu
12°44′24″	83°22′45″	Cayo King	Nicaragua	3,785	3,113		1,720		clagueux@wcs.org
			Nicaragua						clagueux@wcs.org
			Nicaragua	1,097	2,955				clagueux@wcs.org
12°44′24″	82°35′15″	Nee Reef	Nicaragua	2,667	2,954		1,660		clagueux@wcs.org
12°39′24″	82°35′15″	Buscan	Nicaragua	1,383	3,157		1,525		clagueux@wcs.org
9°21′6.7″	82°13′22.4″	Flores Bank, B. Toro	Panama	756	3,591		1,315		Anne.Meylan@fwc.state.fl.us
12°59′25.5″	83°24′37.0″	Auhuya Pihini	Nicaragua	788	3,157	4.01	1,710		clagueux@wcs.org

* Asterisks indicate a single turtle recaptured more than once.

APPENDIX 2. Comparison across regional tagging programs of the proportion of flipper-tagged Green Seaturtles that were recaptured in Cuban habitats. Only data from source populations from where information on total number of tags used were available are included in this table. WJ = wild juveniles; HJ = head started juveniles; A = adults.

Origin of tagging and tagging program	Estimate of source population size (period) [source]	Total number of flipper tags applied by tagging program and source [source]	Life stage	Tags recaptured from this tagging origin in Cuba (*N*)	Proportion of total recaptures in Cuba from this origin (%)	Proportion of tag applied at this origin recaptured in Cuba (%)
Inagua + Central Bahamas (Archie Carr Center for Sea Turtle Research Bahamas project)	mixture of regional populations[1]	1744	WJ	55	14.1	3.15
Grand Cayman (Cayman Turtle Farm Ltd.)	source is reared in captivity and of mixed origin[2]	9300 yearlings 1981–2001[2]	HJ	176	45.0	1.89
Bermuda (Bermuda Turtle Project)	mixture of regional populations[3]	2200 1968–2003[8]	WJ	21	5.4	0.95
Quintana Roo, México (INP-SEMARNAT, X'Caret)	430 nesting females/yr in 1998 (without Cozumel)[4]	1029 yearlings 1966–2000[9]	HJ	9	2.3	0.87
		2541	A	4	1.0	0.16
Tortuguero, Costa Rica (Caribbean Conservation Corp.)	19,300 nesting females/yr[5]	30,700 1980–2002[5]	A	102	26.1	0.33
Florida (various programs) USA (including Florida Dept. Nat. Resources)	759 nesting females/yr[6]	18,000 yearlings 1959–1989[11]	HJ	7	1.8	0.04
Florida		3511	WJ	6	1.5	0.17
Florida		2536	A	5	1.3	0.20
Isla Aves, Venezuela (Fundación para la Defensa de la Naturaleza)	267 nesting females/yr[6,7]	4500 1973–2002[7]	A	5	1.3	0.11
U.S. Virgin Islands	?	?	A	1	0.26	?
Yucatán, México (INP-SEMARNAT)	370 nesting females/yr in 1998 (without Alacranes reef)[4]	1200 1990–2000[4]	A	0	0.0	0.00
Campeche, México (INP-SEMARNAT)	221 nesting females/yr in 1998 (without Arcas reef)[4]	930 1992–2001[12]	A	0	0.0	0.00
Totals	—	78,191 + ?		391	100.0	

[1] Lahanas et al., (1998).
[2] Bell et al., 2005.
[3] Engstrom et al., (1998).
[4] M. Garduño, unpubl. data.
[5] Bjorndal et al., (1999).
[6] Seminoff (2002).
[7] Sole, G. (1994); V. Vera, unpubl. data.
[8] P. Meylan, A. Meylan, and J. Gray unpubl. data.
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[10] S. Tröeng, unpubl. data/CCC at www.cccturtle.org.
[11] Huff (1989).
[12] V. Guzmán, unpubl. data.