

Historical Records of Loggerhead Sea Turtle (*Caretta caretta*) Nesting at Tortuguero, Costa Rica

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ABSTRACT.—Costa Rica is considered a hot spot for biodiversity and wildlife conservation in Central America, and sea turtles are a good example of this. Largely distributed along both the Caribbean and Pacific coast, adult females of five of the seven extant sea turtle species select beaches on both coasts as their breeding sites. Although Green Sea Turtles (*Chelonia mydas*), Leatherback Sea Turtles (*Dermochelys coriacea*), Hawksbill Sea Turtles (*Eretmochelys imbricata*), and Olive Ridley Sea Turtles (*Lepidochelys olivacea*) have been extensively studied in Costa Rica, little information regarding Loggerhead Sea Turtles (*Caretta caretta*) is available. Thus, we present an exhaustive data record of every Loggerhead encountered at Tortuguero beach (northeastern Caribbean coast of Costa Rica) over the past 60 yr. We collected Loggerhead nesting data between 1957 and 2021 through daytime and nocturnal monitoring activities. We documented 14 Loggerhead Sea Turtle nesting attempts between 1957 and 2021 at Tortuguero. Among them, seven nested successfully, four did not lay eggs, and one's fate is unknown. Additionally, two turtles were killed by jaguars. Mean minimum curve carapace length (CCL_{min}) measurements for Loggerheads was 98.2 ± 3.7 cm (range, 90.0–101.4 cm). Finally, we found that every encounter occurred between April and July, which coincides with the Loggerhead nesting season in the Northwest Atlantic. Our study is the first assessment of Loggerhead Sea Turtles nesting in Costa Rica, bringing to light new records for this species in the Caribbean Sea.

Despite its small size of about 51,000 km² and with just under 1,300 km of coastline, Costa Rica is considered a biodiversity hot spot and is a nation with strong wildlife conservation policies in Central America (Jiménez et al., 2017; Samper-Villareal et al., 2020). Sea turtles are among the charismatic megavertebrates that enjoy significant conservation protections in the country. Largely distributed along both the Caribbean and Pacific coasts, endangered Green Sea Turtles (*Chelonia mydas*) (Seminoff, 2004), critically endangered Hawksbill Sea Turtles (*Eretmochelys imbricata*) (Mortimer and Donnelly, 2008), vulnerable Olive Ridley Sea Turtles (*Lepidochelys olivacea*) (Abreu-Grobois and Plotkin, 2008), endangered Leatherback Sea Turtles (*Dermochelys coriacea*) (IUCN, 2019), and the vulnerable Loggerhead Sea Turtles (*Caretta caretta*) (Ceriani and Meylan, 2017) select beaches on both oceans as their nesting locations (Chacón et al., 1996; Valverde et al., 1998; Bjørndal et al., 1999; Troëng, 2000; Gaos et al., 2010; Ceriani and Meylan, 2017). Furthermore, the country holds some of the most important rookeries worldwide for Olive Ridley Sea Turtles (Cornelius et al., 1991; Bernardo and Plotkin, 2007) and Green Sea Turtles (Bjørndal et al., 1999; Limpus et al., 2003; Troëng and Rankin, 2005).

Loggerheads nest across subtropical and temperate regions, with the most important nesting assemblages being located in the Northwest Atlantic (Ceriani and Meylan, 2017; Phillips et al., 2021). Worldwide, there are only 2 rookeries where reported annual nest numbers for Loggerheads exceed 50,000 clutches (Laloë et al., 2020), namely, Masirah Island in Oman (Wilson et al., 2020) and Florida in the United States (Ehrhart et al., 2014; Phillips et al., 2021). However, nesting Loggerheads also occur in the Western Hemisphere within the Caribbean Sea along the coast in Central America, northern South America, the Antilles, and the Bahamas (Ceriani and Meylan, 2017).

Around the Caribbean, Loggerheads nest in low numbers at sites such as Panama (Engstrom et al., 2002), Cuba (Moncada et al., 2010), Colombia (Amoroch, 2003), and the Yucatan

Peninsula in Mexico (Tucker et al., 2014). In the Costa Rican Caribbean, Loggerheads are rarely documented at nesting sites (Arroyo-Arce et al., 2017; Casale and Tucker, 2017; Mejías-Balsalobre et al., 2021; Pheasey et al. 2021). In Tortuguero, Loggerheads nest sporadically and have been documented nesting over the past 60 yr. Although every other sea turtle species has been extensively documented in Costa Rica, little information regarding Loggerheads is available for the country. Therefore, the aim of our study was to present a comprehensive nesting record of the Loggerhead Sea Turtle at Tortuguero, Costa Rica over the past 60 yr.

MATERIALS AND METHODS

The Tortuguero rookery is located on the eastern Caribbean coast of Costa Rica (10.4489°N, 83.5069°W). It extends over 29 km of coastline (Troëng and Rankin, 2005; Pheasey et al., 2021) (Fig. 1a,b), and it is bordered by the Tortuguero village, the Archie Carr Wildlife Refuge, and the Tortuguero National Park (TNP) (Mejías-Balsalobre et al., 2021). For over 60 yr, the Sea Turtle Conservancy (formerly Caribbean Conservation Corporation) has monitored daily the sea turtle nesting activity at this rookery. Every year from March to October, we recorded the nesting events of Green, Hawksbill, Leatherback, and Loggerhead Sea Turtles throughout each nesting season. Loggerhead nesting events co-occur with Hawksbill Sea Turtle and Green Sea Turtle nesting at Tortuguero (Bjørndal et al., 1999; Troëng and Rankin, 2005; Saragoça Bruno et al., 2020).

We collected Loggerhead nesting data from March to October between 1957 and 2021. We conducted night patrols and early morning censuses on a daily basis along the northmost 8 km of the beach (Bjørndal et al., 1999). Additionally, we carried out weekly track surveys, monitoring the entire length of the beach (29 km) to record sea turtle nesting activity from the night before (Troëng and Rankin, 2005). For each encounter, we recorded species, date, beach sector marker, and nesting event (whether the turtle laid eggs or not).

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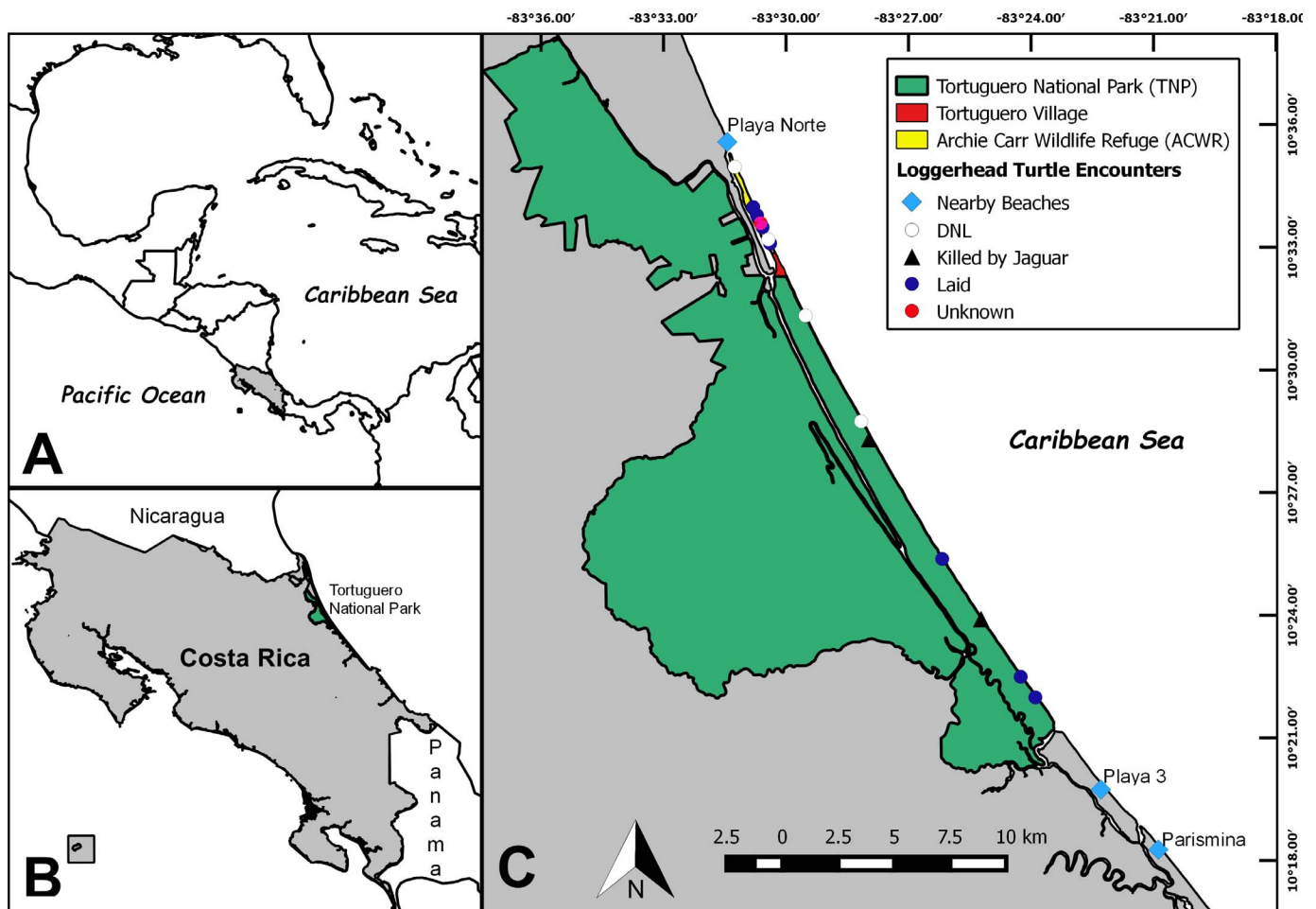


FIG 1. (a) Geographical location of Costa Rica in Central America. (b) Geographical location of Tortuguero National Park in Costa Rica. (c) Detail of the Tortuguero rookery location, including Tortuguero National Park and the location of Loggerhead Sea Turtles encountered between 1957–2021.

We classified the Loggerhead encounter as unknown when the nesting event was not recorded. Each nesting turtle was checked for previous tags, and untagged turtles were tagged on both fore flippers with unique Inconel tags (Meylan et al., 2013) to monitor individual nesting history. When possible, we measured the minimum curve carapace length (CCLmin) from the anterior point nuchal scute to the posterior notch at midline between the supracaudal scutes (Bolten, 1999). Lastly, we determined if a turtle had been killed by jaguars when the carcass was found with jaguar tracks around and bite marks were present on the neck area of the turtle (Fig. 2) (Verissimo et al., 2012; Arroyo-Arce et al., 2017).

RESULTS

Between 1957 and 2021, we documented 14 Loggerhead Sea Turtle nesting attempts at Tortuguero (Fig. 3), including 12 newly tagged individuals (Table 1). Also, we recorded a female originally tagged in 2001 and found again after three nesting seasons in 2004, almost to the date. In 2012, we recorded three Loggerhead nesting events, including one renesting turtle that had been tagged that same year, 12 days prior to the second encounter (Table 1). We registered all encounters with Loggerhead Sea Turtles between April and July.

We encountered 8 out of the 14 Loggerhead Sea Turtles within the northernmost 8 km of Tortuguero and the remaining 6 between kilometers 8 and 29 of TNP. Half of the recorded

Loggerheads ($n = 7$) were females that nested successfully. Out of the remaining turtles, four did not lay eggs, one had an unknown fate, and two were killed by Jaguars (*Panthera onca*) before they were able to lay eggs at 23.2 and 13.6 km, respectively (Fig. 1c, 2). Mean CCLmin for the measured Loggerhead Sea Turtles was 98.2 ± 3.7 cm (range, 90.0–101.4 cm; $n = 9$).

DISCUSSION

Only 14 Loggerhead Sea Turtle nesting attempts have been documented at Tortuguero over the past 6 decades. However, if we consider the extension of TNP (29 km) and the monitoring limitations, it is possible that not all the Loggerhead nesting events were documented. Identification of sea turtle nesting areas is essential, as such information could be useful as a conservation tool for designing and implementing national management policies at local, regional, or global scales (Hamann et al., 2010). In this regard, our study represents the first detailed assessment of nesting Loggerhead Sea Turtles in Costa Rica. Therefore, because nesting in the country may be more extensive than shown in this focused study, it is important to continue gathering information about this species' occurrence on the Costa Rican Caribbean coast to better understand the regional Loggerhead population.

In addition to our findings, unofficial reports of six Loggerhead Sea Turtle nesting attempts have been found in Costa Rica on beaches adjacent to Tortuguero (Fig. 1c). The following three



FIG 2. Nesting Loggerhead Sea Turtle killed by jaguar (*Panthera onca*) in Tortuguero National Park in 2021. Jaguar tracks were covered by the presence of scavenging vultures; the carcass was dragged by the jaguar into the thick vegetation later that day. Photo: Ben Luke.

encounters were recorded nesting in Playa Norte, just 5 km north of TNP: two in 2006 and one in 2017 (J. Gutiérrez-Lince and M. Hughes, pers. com.). Similarly, two Loggerhead nesting attempts were documented at Parismina beach, south of TNP, by the Association Save the Turtles of Parismina (ASTOP) in 2015 and 2019. Finally, in 2020, a nesting Loggerhead was reported on Playa 3, just 2 km south of TNP's southern limit (R. Saragoça Bruno, pers. com.). These reports suggest that perhaps the occurrence of Loggerhead Sea Turtles is frequent at other nesting sites on the Caribbean coast of Costa Rica. Furthermore, these findings highlight the importance of collaboration among sea turtle organizations to gather reliable information that will improve our knowledge of this species in the Caribbean.

Mean CCLmin for Loggerhead Sea Turtles documented at Tortuguero (98.2 ± 3.7 cm) was similar to that described at other nesting sites around the North Atlantic, such as the Archie Carr National Wildlife Refuge in Florida (98.2 ± 0.15 cm) (Ehrhart et al., 2014) and Isla Juventud in Cuba (98.5 ± 10.3 cm)

(Moncada et al., 2010). It has been estimated that the minimum size interval in the western North Atlantic in a Loggerhead nesting assemblage was 68.1–79.1 cm of straight carapace length (SCL) (Phillips et al., 2021). Considering the difference between the measurements of CCLmin and SCL in sea turtles (Bolten, 1999), this could suggest that Loggerhead Sea Turtles documented at Tortuguero are larger than the ones documented previously (Phillips et al., 2021). However, because of the low number of Loggerheads found at Tortuguero, there is not enough information to make such a claim.

Furthermore, most of the records for Loggerhead Sea Turtles documented at Tortuguero occurred between May and July. This might be related to the nesting season in the western North Atlantic for this species, which extends from May to August (Ehrhart et al., 2014; Ceriani et al., 2017; Phillips et al., 2021). However, given that the Loggerhead nesting season co-occurs with that of Hawksbill Sea Turtles and in a vastly smaller proportion with that of Green Sea Turtles at Tortuguero, misidentification of Loggerhead nesting activity is to be expected. Green Sea Turtles emerge from the ocean, leaving behind a distinct set of tracks, and nests are easily identified because they



FIG 3. Female loggerhead turtle (*Caretta caretta*) being marked, measured and weighted after successfully nesting at Tortuguero beach. Photo: Alan Bolten.

TABLE 1. Loggerhead Sea Turtles (*Caretta caretta*) documented at Tortuguero, Costa Rica between 1957 and 2021.

Date	Nesting event	Turtle identifier	Mean CCLmin (cm)	Beach mark (km)
29 July 1957	Unknown	563		2.8
9 July 1990	Laid eggs	50238		2.4
6 May 1998	Did not lay	80029		7.4
15 May 1998	Laid eggs	80037		12.8
24 May 2001	Did not lay	89076	100.7	3.6
20 May 2004	Did not lay	89076	101.4	3.0
7 July 2007	Did not lay	107259	98.8	0.0
12 April 2010	Laid eggs	116967	100.0	20.8
6 June 2012	Laid eggs	123516	98.4	27.4
18 June 2012	Laid eggs	123516	99.1	26.2
7 July 2012	Laid eggs	123971	100.7	2.0
14 May 2014	Killed by jaguar	14/001		13.6
5 July 2015	Laid eggs	135612	94.4	3.8
28 June 2021	Killed by jaguar	21/005	90.0	23.2

create 0.5-m-deep craters during the nesting process, spraying soft, dark sand, that covers a large portion of the nesting site (Bjorndal et al., 1999; Tröeng and Rankin, 2005). Thus, it is possible that the overlap of these species during their nesting seasons may have affected the positive identification of Loggerhead tracks and nesting attempts. Therefore, it is highly possible that during the past 60 yr of monitoring activities, not all Loggerhead tracks were detected, leading to an underestimation of their nesting activity at Tortuguero.

Finally, our findings show that Loggerhead nesting numbers at Tortuguero are minute when compared with larger Loggerhead nesting assemblages like those of the east coast of Florida, which hosts one of the largest Loggerhead nesting colonies in the world, representing approximately 87% (53,000–98,000 nests per yr) of the nesting activity in the Northwestern Atlantic (Ehrhart et al., 2014; Ceriani and Meylan, 2017; Phillips et al., 2021). However, our findings bring to light new records of nesting Loggerhead Sea Turtles in the Caribbean Sea and highlight the importance of data collection to improve appropriate conservation and management strategies to better understand and protect key areas for nesting individuals in Central America. Additionally, this study shows the importance of Tortuguero as a rookery for the conservation of different sea turtle nesting populations and the strategic role Costa Rica plays in the protection of these endangered species.

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