Status of Loggerhead Turtles (*Caretta caretta*) within Nations of the Inter-American Convention for the Protection and Conservation of Sea Turtles

CIT-CC20-2023-TEC.21

IAC Scientific Committee

Prepared by

Dr. Jeffrey Seminoff and MSc. Kirah Foreman-Castillo

Photography: Projecto Tamar

Published by the Secretariat Pro Tempore of the Inter-American Convention for the Protection and Conservation of Sea Turtles

COVER PHOTO: © Loggerhead Turtle – Projecto Tamar

Document Citation

CIT. 2023.Status of Loggerhead Turtles (Caretta caretta) within Nations of the Inter-American Convention for the Protection and Conservation of Sea Turtles.CIT-CC20-2023-Tec.21. IAC Secretariat. Virginia, USA.

This publication is available electronically at: www.iacseaturtle.org and from:
IAC Secretariat
5275 Leesburg Pike, Falls Church, VA 22041-3803 U.S.A
Tel.: + (703) 358 -1828
E-mail: secretario@iacseaturtle.org; contact@iacseaturtle.org

Status of Loggerhead Turtles (*Caretta caretta*) within Nations of the Inter-American Convention for the Protection and Conservation of Sea Turtles

CIT-CC20-2023-Tec.21

IAC Scientific Committee
Prepared by:
Dr. Jeffrey Seminoff and MSc. Kirah Foreman-Castillo

Original Version: December 2016 (CIT-CC13-2016-Tec.13)

Updated Version: September 2023 (CIT-CC20-2023-Tec.21

i. Executive Summary

The loggerhead turtle is a species of concern for the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC), as it is subjected to many threats in the region, and population sizes are likely diminished relative to their historic levels. Loggerheads nesting on beaches of IAC nations are from two distinct Regional Management Units (RMUs), including the Northwest Atlantic and Southwest Atlantic RMUs, and loggerheads occurring in waters of IAC nations originate from four RMUs, with the addition of the North Pacific and South Pacific RMUs for turtles that nest in the western Pacific and access eastern Pacific waters of US, Mexico, Ecuador, Peru and Chile, all countries where no nesting occurs (Figure i; Wallace *et al.* 2010). Together, loggerheads in the IAC region, including stocks that only forage in the Americas, make up approximately 75% of the world's total loggerhead population (IUCN Red List 2015). Therefore, the IAC region can be considered a stronghold for the species. In 2015, during the 7th IAC Conference of the Parties (COP) (24-26 June 2015, Mexico City), COP representatives adopted the “Resolution on the Conservation of the Loggerhead Sea Turtle (*Caretta caretta*)” (CIT-COP7-2015-R3) in which they requested to the IAC Scientific Committee to develop a summary report of the status of all loggerhead populations in the IAC Convention area. The original loggerhead status report was produced in 2016 (CIT-CC13-2016-Tec.13); the current report provides an update to the original IAC status assessment. Data herein were provided in IAC signatory countries’ Annual Reports, and by members of the IAC Scientific Committee.

A total of at least seven (7) IAC nations have nesting within their borders, including Belize, Brazil, Mexico, Caribbean Netherlands, Panama, Venezuela, and the United States. Data have been gathered from a total of 17 index nesting beaches among these nations. Based the most recent 3 years of data for the index sites with available data, there are 120,853 total nests deposited each year, which equates to 29,476 nesting females per year. Long-term (>10 yrs.) nesting data are available for loggerheads at 1 index beach in Belize (stable-to-decreasing trend), 6 in Brazil (stable-to-decreasing trends), 1 in Caribbean Netherlands (possibly decreasing trend), 1 in Mexico (stable-to-increasing trend), and 1 in United States (stable-to-increasing trend). Two countries (Peru and Chile) in addition to Pacific Mexico only host foraging turtles, all of which originate from nesting beaches outside the IAC region. Loggerheads foraging in Pacific Mexico originate from the Japanese nesting beaches, while those foraging in Chile and Peru originate from Australia and, to a lesser extent, New Caledonia. Recent nesting data for these source populations are unavailable; however, the Japanese stock is thought to be stable-to-increasing, whereas Australia stocks are thought to be decreasing (IUCN Red List, 2016). No information is available from New Caledonia.

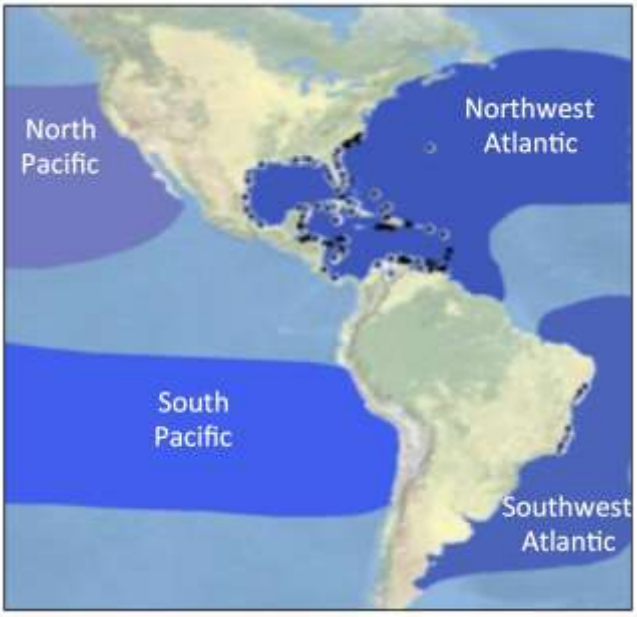

Figure i. Map of Regional Management Units of loggerhead turtles in the IAC region. Modified from Wallace *et al.* (2010).

Threats to loggerheads are similar across the entire IAC region and include pollution and marine debris, artificial lighting, fisheries bycatch, harvest, coastal development/vessel strikes, and habitat loss. The most ubiquitous threats are fisheries bycatch and coastal development. Impacts from climate change are also thought to occur across the IAC region, although their effects are often subtle and difficult to quantify.

Based on this summary report, the IAC Scientific Committee in consultation with Consultative Committee of Experts will identify the main actions for the IAC Parties to undertake to improve the conservation status of all loggerhead turtles. However, as a preliminary list of conservation actions we recommend the following:

International Conservation and Partnerships

- Establish and strengthen partnerships with governmental and NGO groups in Japan and Australia to promote loggerhead conservation.
- Strengthen collaboration with CMS to jointly implement their 2014 document: Single Species Action Plan for the Loggerhead Turtle (*Caretta caretta*) in the South Pacific Ocean.

Nesting Beaches Conservation and Monitoring in IAC countries

- Maintain monitoring efforts (time and space) at all IAC loggerhead index nesting beaches so as to build and maintain a dataset that will eventually enable long-term trend analysis for all nesting sites.
- Work among IAC parties and NGO partners to promote nesting beach protection at loggerhead nesting beaches in each respective IAC nation.
- Promote sea turtle-friendly nesting beach lighting ordinances in each of the nations that have been impacted by coastal development, when and where appropriate.
- For nesting beach monitoring, it is important to also focus on smaller nesting assemblages to understand the annual nesting trends in these areas.
- Conduct an assessment of loggerhead nesting status in IAC Nations (i.e., an update of this document) every 5 years.

Direct Harvest and Fisheries Bycatch

- Ensure that loggerhead direct take is eliminated from all areas currently identified as having this problem; this includes in-water and nesting beach harvest.
- Conduct robust bycatch analysis in all nations identified as having this threat to pinpoint the gear types and fleets that are having the greatest impact; work with local partners to promote bycatch reduction technologies in these areas.

ii. Approach to Assessment

The report is directly related to Element 3 of the Loggerhead Resolution CIT-COP7-2015-R3 *"Request to the IAC Scientific Committee to develop a summary report of the status of all loggerhead populations in the IAC area every four years".* The initial planning for this report occurred during the 12th IAC Scientific Committee Meeting in Valparaiso, Chile during which a Loggerhead Working Group (WG) was developed which included representatives from Brazil, Caribbean Netherlands, Belize, Chile, Ecuador, Guatemala, Honduras, and US (Chair). The WG agreed that this summary report should draw on existing reviews by the IUCN Red List (IUCN 2016), Convention on Migratory Species (CMS 2016), the US Endangered Species Act loggerhead assessment (Conant *et al.* 2008), the Indian Ocean South East Asian loggerhead review (Hamann *et al.* 2013), and data from IAC annual reports and technical documents. However, now that significant years of information for the majority of IAC loggerhead index beaches are available in the IAC Annual Reports, the current report emphasizes IAC Annual Report data over other data sources.

To determine loggerhead status in the IAC region, we characterize a) loggerhead abundance and trends, and b) ongoing threats to the species in each IAC country. In terms of abundance and trend data, only a subset (n=7) of all IAC countries has loggerhead nesting on their beaches, including Belize, Brazil, Caribbean Netherlands, Mexico, Panama, United States, and Venezuela. For these countries, nesting data focus on IAC index nesting beaches as per the IAC Technical Document entitled "*Selecting Index Nesting Beaches in the IAC Region and Data Collection Guidelines"* (CIT-CC10-2013-Tec.5). The initial data used for this report come from the IAC Technical Document

CIT-CC11-2014-Doc.3 entitled “IAC Index Nesting Beach Data Analysis (2009–2013)”. Additional data were gathered from Annual Reports as well as data requests made directly to Scientific Committee members for respective IAC countries. All data sets start in 2009, as this was the initial year for which data were requested for the IAC Index Nesting Beach Report.

Most data were provided in terms of the number of nests per season. To develop estimates of current adult female population sizes, we made conversions based on the nesting parameters of 4.1 clutches per season and a mean inter-nesting interval of 3 years per turtle (Schroeder *et al.* 2003). For this latter estimate, we used the most recent three years of data that were available. This allowed us to attain an estimate of total ‘current’ number of adult females in the population, which we compare to the same metric reported in the 2014 report. For countries with no nesting, we include maps to show the distribution of loggerheads in coastal waters.

This report also describes the ongoing threats to loggerhead populations in each IAC country. Because loggerheads occur in marine habitats throughout the IAC region, our analysis includes all IAC nations, including those with and without loggerhead nesting. We develop a threat table (Table 4.1.3.1) to identify highest priority threats, using information from IAC annual reports, as well as information in Wallace *et al.* (2011), and Bolten *et al.* (2010). Threats were divided into six categories and represented as present or absent, similar to the format within the IAC annual reports.

The current report provides an update to the original assessment that was developed in 2016 (CIT-CC13-2016-Tec.13). This update was conducted by the IAC Scientific Committee and drew from input from a variety of IAC Scientific Committee delegates and other IAC turtle experts. The data in this update includes nesting data up to 2022. A draft of the updated report was distributed to the entire Loggerhead WG and additional loggerhead experts from IAC countries for comment and improvement, and their suggested changes were incorporated into this final version that was presented at the 20th IAC Scientific Committee meeting in 2023. The coordinators of the present update of this document were the Scientific Committee Delegates from the United States Dr. Jeffrey Seminoff and from Belize Dr. Kirah Foreman.

1. Species Background

1.1 Taxonomy

Kingdom: Animalia
Phylum: Chordata
Class: Reptilia
Order: Testudines
Family: Cheloniidae
Genus: *Caretta*
Species: *caretta*

The loggerhead was first described by Linnaeus in 1758 and named *Testudo caretta*. Over the next two centuries more than 35 names were applied to the species (Dodd 1988), but there is now agreement on *Caretta caretta* as the valid name. While Deraniyagala described an Indo-Pacific form as *C*. *gigas* in 1933, he revised that view in 1939 to hold that *gigas* was a subspecies of *C*. *caretta* (Deraniyagala 1933, 1939). The genus has been regarded as monotypic since that time. The subspecific designation of *gigas* has likewise been challenged persuasively (Brongersma 1961, Pritchard 1979). Thorough synonymies and taxonomic reviews of this form were presented by Pritchard and Trebbau (1984) and Dodd (1988) in the 80s.

1.2. Common names

The following is a list of the various common names applied to *Caretta caretta* in IAC nations. These are the names that were provided by IAC country representatives.

Argentina: *Cabezona*
Belice: *Loggerhead*
Brazil: *Tartaruga-cabeçuda, tartaruga-amarela, tartaruga-mestiça, tartaruga-avó, avó-de aruanã, careba-amarela, careba-dura.*
Chile: *Cabezona*
Costa Rica: *Cabezona, Caguama*
Honduras: *Loggerhead, Cabezona*
Mexico: *Amarilla, Javalina, Perica, Cabezona, Xpeyo, Caguama*
Caribbean Netherlands: *Loggerhead*
Panama: *Boba, Cabezona, Caguama*
Peru: *Amarilla, Cabezona, Bastarda*
United States: *Loggerhead*
Venezuela: *Cabezona, Caguama, Maní, Amarilla*

1.3 Conservation status under ESA and IUCN management frameworks

The loggerhead sea turtle is included in both the IUCN Red List and the U.S. Endangered Species Act. Under the IUCN Red List, loggerheads are split into 10 different Regional Management Units as per Wallace *et al.* (2011). For the U.S. Endangered Species List, loggerhead turtles are separated into eight Distinct Population Segments (DPSs). A summary of these varying conservation listings for DPSs occurring within the IAC region is provided below in Table 1.3.1.

Table 1.3.1. Summary of conservation status of loggerhead turtles on the U.S. Endangered Species List and the IUCN Red List pertaining to the IAC region. The IUCN lists loggerheads on a regional scale based on Regional Management Units (RMUs; Wallace *et al.* 2010), with the most recent IUCN regional/global evaluation completed in 2015. The U.S. Endangered Species Act (ESA) lists loggerheads on a regional scale based on Distinct Population Segments (DPSs; Conant *et al.* 2009) which are similar, but not the same as RMUs. The most recent ESA loggerhead assessment was in 2011.

Loggerhead Regional Population	IUCN Status	ESA Status	Beach Length (km)	Estimated # of Females (IUCN RLA 2015)	Estimated # of Females (this report)
Northwest Atlantic	Least Concern	Threatened	>2610	30000	>80,000
Southwest Atlantic	Least Concern	Threatened	711	3848	3,042
North Pacific (Japan)	Least Concern	Endangered	1635	8100	unknown
South Pacific (Australia)	Critically Endangered	Endangered	~1000	<700	unknown
GLOBAL	Vulnerable				

2. Species Biology

2.1 Range

The loggerhead occurs throughout the temperate and tropical regions in waters of signatory nations of the IAC, including the Atlantic and Pacific Oceans, Caribbean Sea, Gulf of Mexico, and Gulf of California (Wallace *et al.* 2010). Nesting in IAC nations only occurs in the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico among seven IAC countries: Belize, Brazil, Mexico, Caribbean Netherlands, Panama, Venezuela and the United States. Nesting may also occur in Atlantic Guatemala, Honduras, and Costa Rica, but data are unavailable. Within the North Pacific, loggerhead nesting has been documented only in Japan (Kamezaki *et al.* 2003), although low-level nesting may occur outside of Japan in areas surrounding the South China Sea (Chan *et al.* 2007). In the South Pacific, nesting beaches are restricted to eastern Australia and New Caledonia and, to a much lesser extent, Vanuatu and Tokelau (Limpus and Limpus 2003). Loggerheads found in Pacific Mexico originate from Japan whereas those off the coasts of Peru and Chile originate from Australia and New Caledonia.

2.2. Biology in foraging and nesting areas

Significant research has been conducted on loggerhead turtles around the world. Here we summarize their biology, relying heavily on information and data summarized in Conant *et al.* (2008).

Loggerheads nest on ocean sandy beaches and sometimes within semi-enclosed shorelines. Nesting beach characteristics vary between rookeries, but tend to be wide and sandy and backed by low dunes and fronted by a flat, sandy approach from the water (Miller *et al.* 2003). Nests are typically laid between the high tide line and the dune front (Bolten and Witherington 2003).

Sea turtle eggs require a high-humidity substrate that allows for sufficient gas exchange and temperatures conducive to egg development (Miller *et al.* 2003). Mean clutch size varies greatly between populations, but on average is approximately 100-130 eggs per clutch (Dodd 1988). Loggerhead nests incubate for variable periods of time, but is generally about 45 days (Mrosovsky 1980). Sand temperatures prevailing during the middle third of the embryo development determine the sex of hatchlings (i.e. temperature sex determination, TSD; Mrosovsky and Yntema 1980). Incubation temperatures near the upper end of the tolerable range produce only female hatchlings while incubation temperatures at the lower end of the tolerable range produce only male hatchlings. The pivotal temperature (i.e., the incubation temperature that produces equal numbers of males and females) in loggerheads is approximately 29°C (Limpus *et al.* 1983, Mrosovsky 1988, Marcovaldi *et al.* 1997). Moisture conditions in the nest influence incubation period, hatching success, and hatchling size (McGehee 1990, Carthy *et al.* 2003).
Hatchlings emerge from their nests *en masse* almost exclusively at night, and presumably using decreasing sand temperature as a cue (Witherington *et al.* 1990; Moran *et al.* 1999). Hatchlings use an array of orientation cues to guide their movement from the nest to the marine environments where they spend their early years (Lohmann and Lohmann 2003). Immediately after hatchlings emerge from the nest, they begin a period of frenzied activity. During this active period, hatchlings move from their nest to the surf, swim, and are swept through the surf zone (Salmon *et al.* 1992; Witherington 1995).

Neonate loggerheads that have migrated away from land differ from swim frenzy stage hatchlings in that they are largely inactive and only exhibit infrequent low-energy swimming, and they have begun to feed, no longer relying on their retained yolk (Witherington 2002). As post-hatchlings, loggerheads are pelagic and are best known from neritic waters along the continental shelf. This neritic post-hatchling stage is weeks or months long (Witherington 2002) and may be a transition to the oceanic stage that loggerheads enter as they grow and are carried within ocean currents (Bolten 2003).

In the northwest Atlantic, post-hatchling loggerheads inhabit areas where surface waters converge to form local downwelling (Witherington 2002). These areas are characterized by linear accumulations of floating material, especially *Sargassum*, and are common between the Gulf Stream and the southeast U.S. coast, and between the Loop Current

and the Florida coast in the Gulf of Mexico. Post-hatchlings within this habitat are observed to be low-energy float-and-wait foragers that feed on a wide variety of floating items (Witherington 2002). Witherington (2002) found that small animals commonly associated with the *Sargassum* community, such as hydroids and copepods, were most commonly found in esophageal lavage samples.

The oceanic juvenile stage begins when loggerheads first enter the oceanic zone (Bolten 2003). Juvenile loggerheads originating from nesting beaches in the Northwest Atlantic and West Pacific Oceans appear to use oceanic developmental habitats and move with the predominant ocean gyres for several years or more before returning to their neritic foraging and nesting habitats (Ramirez *et al.* 2015, Turner-Tomaszewicz *et al.* 2015).

The neritic juvenile stage begins when loggerheads exit the oceanic zone and enter the neritic zone (Bolten 2003). After migrating to the neritic zone, juvenile loggerheads continue maturing until they reach adulthood. Some juveniles may periodically move between the neritic and oceanic zones (Witzell 2002, Mansfield 2006, Eckert *et al.* 2008, Barcelo *et al.* 2013, González Carman *et al*. 2016). The neritic zone also provides important foraging habitat, inter-nesting habitat, and migratory habitat for adult loggerheads. Some adults may also periodically move between the neritic and oceanic zones (Harrison and Bjorndal 2006).

The duration of the adult stage can be reasonably estimated for females from tag return data at nesting beaches. For the Northwest Atlantic nesting assemblages, data from Little Cumberland Island, Georgia, show reproductive longevity, and hence duration of adult female stage, as long as 25 years (Dahlen *et al.* 2000). Comparable data for adult males do not exist. The extent to which adult loggerheads occupy oceanic habitats needs to be evaluated, and effects on survival probabilities and reproductive output should be assessed.

In both the oceanic and neritic zones, loggerheads are primarily carnivorous, although they do consume some plant matter as well (see Bjorndal 1997 and Jones and Seminoff 2013 for reviews). Loggerheads are able to exist on a wide variety of food items with ontogenetic and regional differences in diet. Loggerhead diets have been described from just a few coastal regions, and very little information is available about differences or similarities in diet at various life stages.

2.3. Demography

Table 2.3.1 shows a collection of demographic information for loggerhead sea turtles, focusing on the two nesting DPSs within the IAC region. Information includes mean age at first reproduction (AFR), mean size at sexual maturity (SSM), mean clutch size, the mean number of nests one female lays in one season (fecundity), the mean number of days between clutches (inter-nesting period), the number of years between reproductive migrations (migratory period), as well as few variable ranges for reproductive longevity.

Table 2.3.1. Loggerhead demographics for both northwest and southwest Atlantic populations.

DPS	Mean AFR	Mean SSM (cm)	Mean clutch size	Mean renest frequency /season	Inter-nesting interval (days)	Re-migration interval (yrs)	Mean reproductive yrs	Reference
NW Atlantic	18.8		118.7	3.5		2 to 3	4 to 32	1
NW Atlantic				3.6		2.5 to 3.5		2
NW Atlantic	24.5	88.1 (CCL)						3
NW Atlantic				5				4
NW Atlantic	37						19 (4 to 46)	5
SE U.S.	20 to 30							6
SW Atlantic				4.1				9
ALL/ UNK		87	112	3.5	14.0	2.6		7
ALL/ UNK	23 to 35		115	4.1				2
ALL/ UNK				3 to 5.5				8
MEAN	**27.1**	**87.5**	**115.2**	**3.9**	**14.0**	**2.7**	**17.3**	

Sources are as follows: 1) Dodd 1988, 2) Schroeder *et al.* 2003, 3) Avens and Snover 2003, 4) Conant *et al.* 2009, 5) Avens *et al.* 2015, 6) Heppell *et al.* 2003b, 7) Miller 1997, 8) IUCN Red List 2016, 9) P. Hunold Lara, pers. comm.

3. Loggerhead Status in each IAC Country

3.1. Argentina

Figure 3.1.1. Map of distribution of loggerheads from the Southern Atlantic Regional Management Unit, showing the range for the species in waters of Argentina (Based on range shown in Wallace *et al.* 2010; also see González Carman *et al.* 2011, 2016).

3.1.1 Loggerhead Presence

Loggerhead turtles do not nest on the beaches of Argentina, but the coastal waters are important as foraging grounds.

3.1.2 Threats

According to Argentina 2020 IAC Annual Report, sea turtles off the coast of Argentina are most threatened by incidental capture and contamination, both of which are being studied. Within the framework of the ASO Sea Turtle Network, López-Mendilaharsu *et al.* (2020) conducted a multiple-threats analysis for loggerheads in the southwest Atlantic (Brazil, Uruguay and Argentina), and demonstrated that bycatch in marine fisheries is a significant threat. In particular, trawl fisheries in nearshore, neritic zones are the main cause for mortality of both juvenile and adult loggerheads in these areas, and López-Mendilaharsu *et al.* (2020) suggest these impacts may eventually impact overall loggerhead abundance trends in the region. In addition to marine fisheries impacts, seismic exploration has become a potential threat that may impact turtles in migratory corridors and foraging areas (López-Mendilaharsu *et al.* 2020), and plastic ingestion has been reported in loggerheads from Argentina (and southern Brazil), though in very low-to-medium rates (González Carman *et al.* 2021).

3.2. Belize

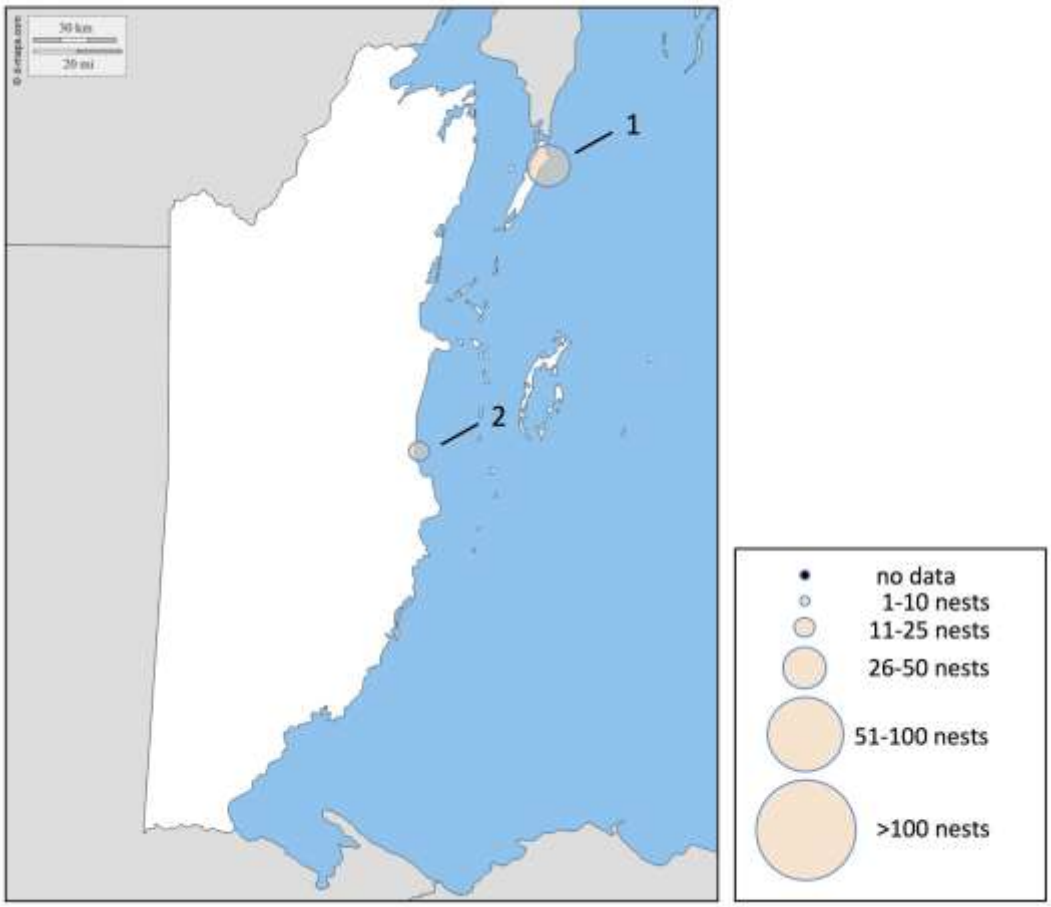

Figure 3.2.1. Map of loggerhead nesting index sites and clutches abundance categories in Belize. See following section for site number associated with each index beach.

3.2.1 Summary of index sites

There are two index nesting sites for Belize: Ambergris Caye (formerly Bacalar Chico) and Gales Point Manatee (started as index site in 2014) as indicated on the map above. Both are located in the northern portion of the county, with Ambergris Caye (Site 1 in Figure 3.2.1) representing various smaller beaches on the island, and Gales Point Manatee (Site 2 in Figure 3.2.1) found on mainland Belize.

3.2.2 Nesting abundance

Data on nesting abundance are available for two primary index beaches in Belize, both of which have data starting in 2009. Since 2019 (Table 3.2.2.1), there have been a mean of 47 nests deposited annually, which equates to a total adult female population size of approximately 34 individuals (based on nesting frequency and total nests).

Table 3.2.2.1. Summary of nest and female abundance at key nesting sites in Belize

Nesting Site	Map Site	2019 Total Nests	2020 Total Nests	2021 Total Nests	2022 Total Nests	Mean Annual Nests (2019–2022)	Mean Annual Nesting Females	Total Adult Females
Ambergris Caye	1	53	29	-	28	37	9.0	27
Gales Point Manatee	2	19	8	11	2	10	2.4	7
TOTAL		**72**	**37**	**11**	**30**	**47**	**11.4**	**34**

3.2.3 Nesting trends

Nesting trend data originated from a combination of the Belize IAC annual reports as well as some correction and updates through personal communication with WG members. Ambergris Caye (formerly Bacalar Chico) typically sees approximately three times as many nesting females as Gales Point/Manatee Bar. In the IAC Scientific Committee CIT-CC13-2016-Tec.13 technical document (CIT-CC13-2016-Tec.13 Rebecca Chapman & Jeffrey A. Seminoff 2016), the mean number of nests deposited from 2011–2013 at Ambergris Caye was 57, which equated to 13.9 mean annual females and 41.7 total females nesting during this period. In the most recent three years of nesting data (2019-2020, 2022) these mean values dropped to 37 mean annual nests and 9 mean annual nesting females. The reasons for this decline are unclear but may be related to changes in sampling effort during the study period.

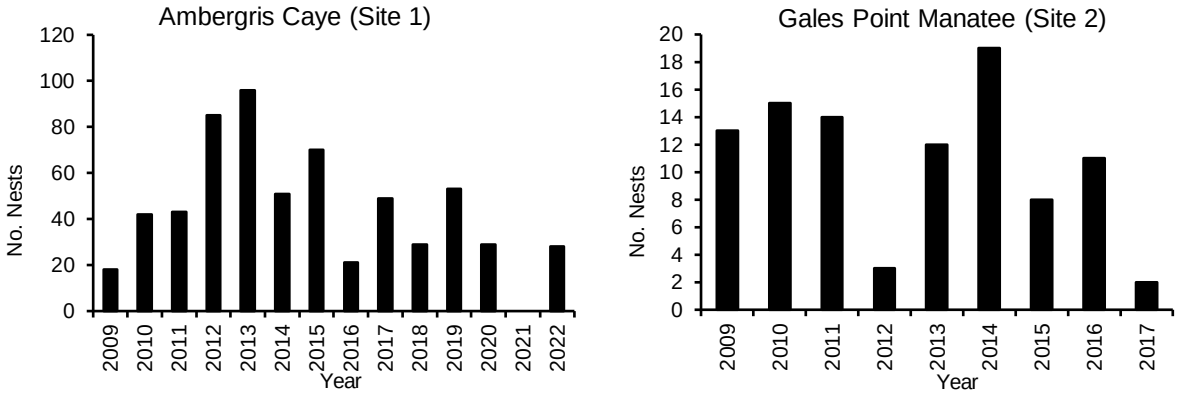

Figure 3.2.3.1. Annual nesting abundance for loggerhead turtles at the Ambergris Caye and Gales Point Manatee (new in 2014) index nesting sites in Belize.

3.2.4 Threats

According to recent annual reports, loggerheads are faced with many threats in Belize. All life stages are affected by pollution: on the beach or floating in the water. Nesting grounds in particular are affected by artificial lighting, loss of beach due to erosion, or coastal construction, and nest predation. Fisheries bycatch is another possible threat to turtles. To reduce this threat, an observer program is being instituted, trawling has been banned, and the use of circle hooks is encouraged (IAC Annual Report 2015).

3.3. Brazil

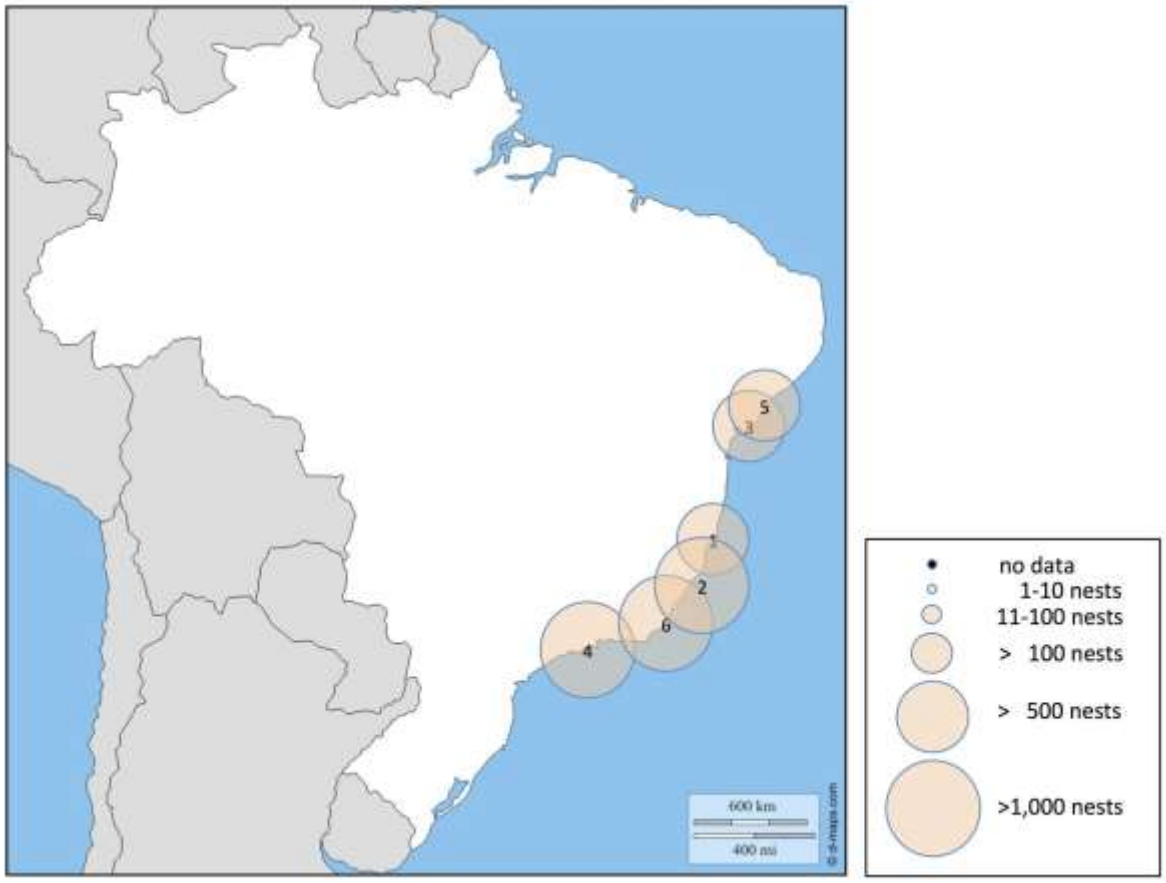

Figure 3.3.1. Map of loggerhead nesting index sites and abundance categories in Brazil. See following sections for site number associated with each index beach.

3.3.1 Summary of index sites

There are six index nesting sites for loggerhead turtles in Brazil. These include Comboios (Site 1 on Figure 3.3.1), Povoação (Site 2), Guarajuba (Site 3), Interlagos (Site 4), Praia do Forte (Site 5), and Farol (Site 6).

3.3.2 Nesting abundance

The annual number of nests within the past three years (2019–2021) at each of Brazil's six index beaches ranged from 91 nests (Guarajuba, 2021) to 1,209 nests (Interlagos, 2019) (Table 3.3.2.1). Mean annual nests deposited for these three years ranged from 458.3 nests (Povoação) to 1108.3 nests (Interlagos) (Table 3.3.2.1). Interlagos continued to have the greatest number of nests among Brazil's six index beaches. When nests are converted to females, the mean females/year for the 3-year period of 2019–2021 ranged 111.8–270.3. When pooled across the three years this equaled a total reproductive female population of 3030.2 females for Brazil's six index beaches.

Table 3.3.2.1. Summary of loggerhead nest and female abundance at index nesting sites in Brazil

Nesting Site	Map Site	2019 Total Nests	2020 Total Nests	2021 Total Nests	Mean Annual Nests (2019–2021)	Mean Annual Nesting Females	Total Adult Females
Comboios	1	748	837	568	717.7	175.0	525.1
Povoação	2	494	550	331	458.3	111.8	335.4
Guarajuba	3	677	697	91	488.3	119.1	357.3
Interlagos	4	1209	1205	911	1108.3	270.3	811.0
Praia do Forte	5	662	658	691	670.3	163.5	490.5
Farol	6	729	837	529	698.3	170.3	511.0
TOTAL		**4519**	**4784**	**3121**	**4141.3**	**1010.1**	**3030.2**

3.3.3 Nesting trends

Long term nesting trends are available for all six index nesting beaches in Brazil, with all showing stable to increasing populations (Figure 3.3.3.1). Whereas mean annual females 2019–2021 among all index beaches was 1108 females/year, from 2013–2015 this value was 1284 females/year. The decrease likely owes in part to the low sample effort in 2021—and correspondingly low nest counts that year—due to Covid logistics.

Brazil reported at the IAC twentieth Scientific Committee in 2023 that the information in this report only includes the index nesting beaches in Brazil, and that Brazil has data from all their nesting beaches for this species that shows a tendency to an increase population.

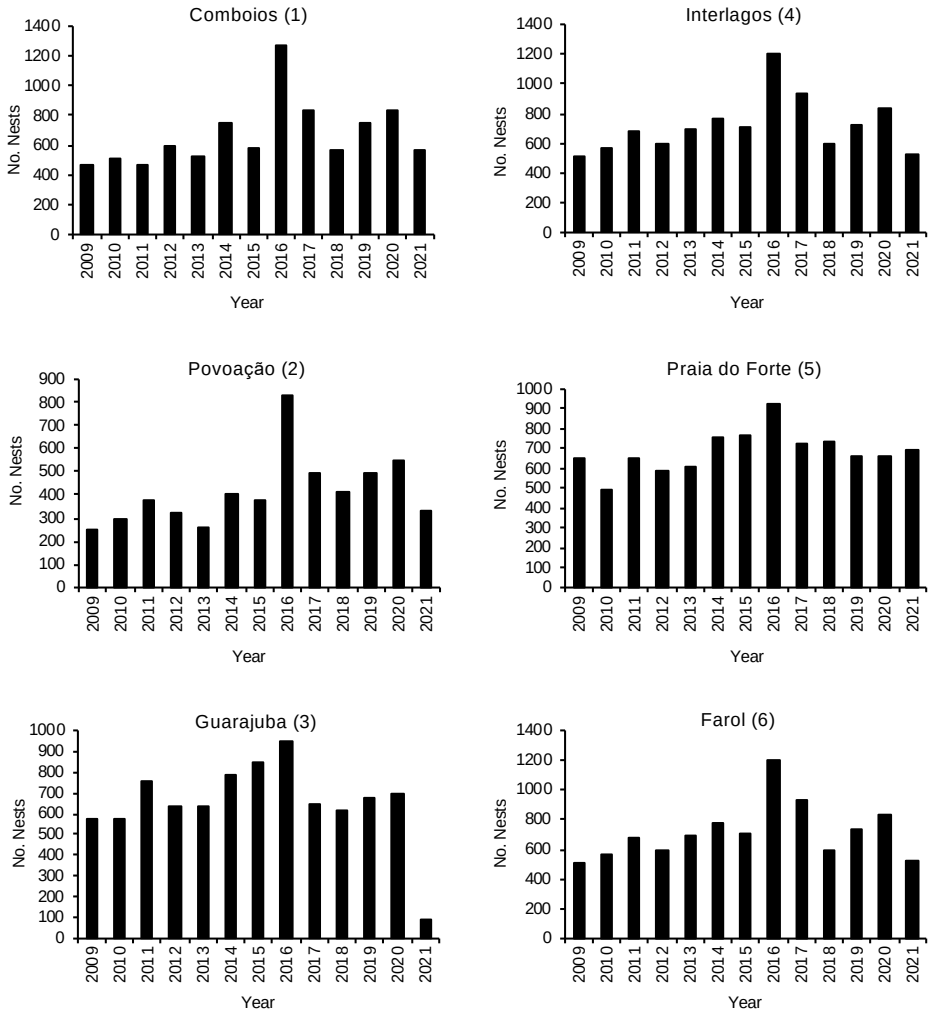

Figure 3.3.3.1. Annual nesting abundance for loggerhead turtles at nesting index sites in Brazil.

3.3.4 Threats

Longline fisheries are considered to have the greatest impact on loggerheads in particular by Wallace *et al.* (2013). Brazil does have temporal trawling closure, and circle hooks are recommended but only on a volunteer basis (Wallace *et al.* 2013). Loss of beach habitat due to both coastal development and climate change are noted in their IAC Annual Report (2015).

3.4. Chile

Figure 3.4.1. Map of South America depicting the range of loggerhead turtles occurring off of the coast of Chile (Based on range shown in Wallace *et al.* 2010).

3.4.1 Loggerhead Presence

Loggerhead turtles are seen foraging off the coast of Chile. These individuals primarily belong to the South Pacific DPS, which is critically endangered (IUCN Red List 2015). Bolten and Witherington (2013) found that between 1977 and 2000 the number of nesting females was reduced from 3,500 to less than 500 (2003). Donoso and Dutton's (2010) bycatch study showed that loggerheads were more common in Northern Chilean waters.

3.4.2 Threats

The primary threat to loggerhead turtles along Chile's coast is becoming bycatch, especially by artisanal long-line fisheries (Donoso and Dutton 2010, IUCN Red List 2015, IAC Chile Annual Report 2015). Other threats listed by the IUCN Red List include artificial light on their nesting beaches and pollution (2015). According to SWOT (State of the World's Sea Turtles), some of the pollution originates from the Chilean mining industry (Alvarez-Varas *et al.* 2011). SWOT also reported that two marine sanctuaries are in the near future and will go a long way to reduce the bycatch total.

3.5. Costa Rica

Figure 3.5.1. Map of possible but unverified loggerhead nesting habitat in Costa Rica.

3.5.1 Loggerhead Presence

Loggerhead turtles are not present in Pacific waters of Costa Rica. Scattered nesting occurs along the Caribbean coast (Dow *et al.* 2007), but data on specific sites and nesting abundance are unavailable.

3.5.2 Threats

On the 2014 IAC Annual Report from Costa Rica, no threats were listed for loggerheads likely due to their low occurrence in the area. The few seen in Costa Rican waters are only on the Caribbean coast (IAC 2014). The four species that do nest here have all six threats marked on the IAC form: coastal development, incidental capture, direct use, contamination, climate change, and pathogens (2014 and 2016).

3.6. Ecuador

3.6.1 Loggerhead Presence

Loggerhead turtles are only occasionally encountered in Ecuadorian waters (Alava 2008) and there are no data available on at-sea abundance.

3.6.2. Threats

Despite only being encountered occasionally in Ecuadorian waters, loggerhead turtles have been reported as being killed via fisheries bycatch (Alava 2008)

3.7. Guatemala

Figure 3.7.1. Map depicts possible but unknown loggerhead nesting beaches in Guatemala.

3.7.1 Loggerhead presence

Dow *et al.* (2007) indicate that there is some loggerhead nesting in Guatemala, but they do not point to any specific beach. They are at least present, foraging on the Caribbean side of Guatemala (Dow *et al.* 2007, IAC annual report). However, so far no data have been provided regarding nesting sites and abundance on the Caribbean coast of Guatemala. Loggerhead turtles are not present on the Pacific side of Guatemala.

3.7.2 Threats

According to the 2015 IAC annual report, loggerheads are threatened by direct use, primarily the harvesting of eggs. This suggests that there is at least occasional nesting by loggerheads, yet no data are available.

3.8. Honduras

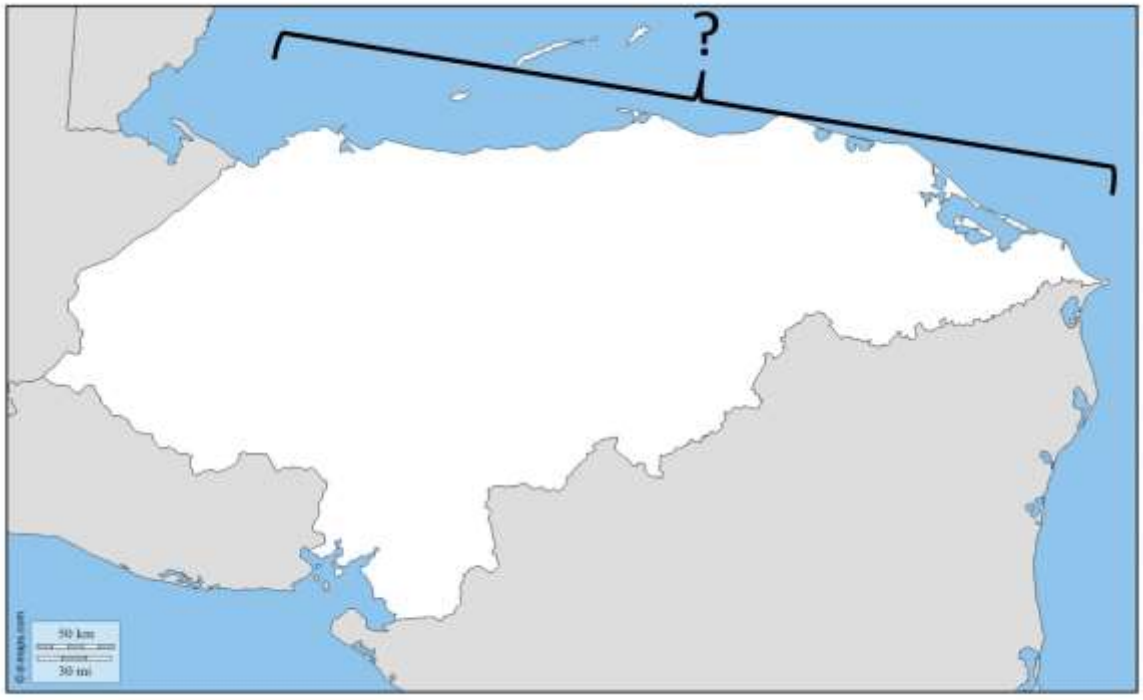

Figure 3.8.1. Map depicts an area of possible Honduran nesting grounds for loggerhead turtles.

3.8.1 Loggerhead Presence

Loggerhead turtles are known to occur on the Caribbean coast, and research is currently being done to find out more about their activity on the Caribbean coast of Honduras (IAC Annual Report 2015). This report also indicates that tagging of loggerheads occurs, but is not specific as to what type of tag or where. There is no mention of nesting beaches or data in the annual reports, although 18 possible nesting beaches were noted by Dow *et al*. (2007). It is unknown whether these beaches are protected or what the level of nesting is, if any.

3.8.2 Threats

Loggerheads in Honduras are threatened by coastal development, incidental captures, direct use, pollution of local waters, and climate change (IAC Annual Report 2016). They do have fishing closures for other species, require TEDs in trawl nets, and a seasonal fishing closure more geared toward olive Ridley turtles. Beach patrols, cleaning of beaches, and educational programs are used to mitigate these threats (IAC Annual Report 2016).

3.9. Mexico

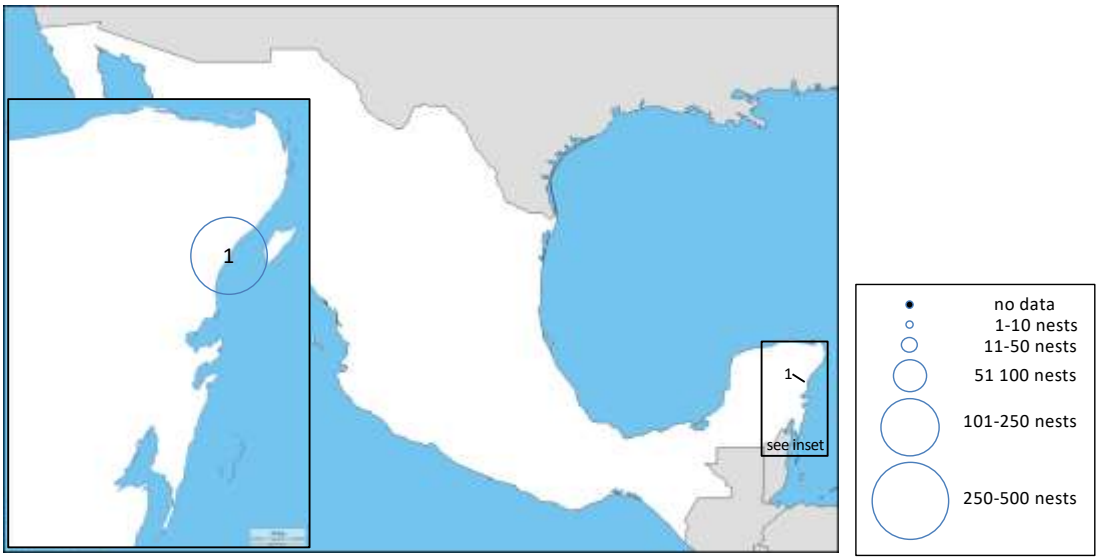

Figure 3.9.1. Map of the Xcacel loggerhead nesting index site in Mexico.

3.9.1 Summary of index sites

Although X´cacel is the only loggerhead index nesting site included in this report for Mexico, nesting also occurs in Tamaulipas, Veracruz, Campeche, and Yucatan; 90% of nests are laid in Quintana Roo, where X'cacel is located (see map inset). Paamul, Aventuras DIF, Chemuyil, X´cacel, Tankah, Kanzul, Cahpechen, and San Juan were established as loggerhead monitoring sites in 1989, there are four primary beaches among these sites (X´cacel, Aventuras DIF, Chemuyil, and Xel-Ha). X´cacel has had the most robust monitoring effort (L. Sarti, Personal Communication, 2021), and thus is the sole index site included in this report. However, it should be noted that because of Covid impacts to monitoring, data for 2021 for Xcacel represent combined data for X´cacel, Chemuyil, Xel Ha, and Aventuras DIF (Previously Puerto Aventuras), Q. Roo.

Nesting abundance

3.9.1.1 Atlantic

All loggerhead nesting in Mexico occurs on their Atlantic/Gulf of Mexico coast. Nesting beach data collection has been inconsistent across years for most beaches, and only X´cacel has had consistent monitoring across the nesting years included in this report (2009–2021). Table 3.9.2.1 below shows numbers of nests for X´cacel for the three most recent years of data, 2019–2021. Within this series of data, nest numbers range from 418 (2021) to 3477 (2019). The total number of reproductive females using the X´cacel index beach is 1744.6 females (Table 3.9.2.1.).

Table 3.9.2.1. Summary of loggerhead nest and female abundance at index nesting sites in Mexico. In 2021, due to Covid logistics the value reported is a cumulative total from multiple nesting beaches, including X´cacel, Chemuyil, Xel Ha, Aventuras DIF (Previously Puerto Aventuras), Q. Roo.

Index Nesting Site	Map Site	2019 Total Nests	2020 Total Nests	2021 Total Nests	Mean Annual Nests (2019-2021)	Mean Annual Nesting Females	Total Adult Females
Xcacel	1	3477	3258	418	2384.3	581.5	1744.6

3.9.1.2 Pacific

No loggerhead nesting occurs on the Pacific coast of Mexico. The foraging loggerheads seen in this area nest in Japan. This population is considered as least concern by the IUCN Red List (2015). No new data are available since the previous IAC assessment. Of their 35 index nesting beaches, 30 beaches had a positive growth change, and only 5 beaches showed a decline based on comparing historic data with that of the 2013 season. The 3-generation change per beach ranged from 5.72 to –0.76, with an overall mean of 1.69 (IUCN Red List 2015, Sea Turtle Association of Japan). The most long-term data come from Kamouda and Hiwasa beaches, going back to the 1950's showing a significant population decrease over the next 40 years (Kamezaki *et al.* 2003). Despite another decrease in 2014, there was an overall increasing trend from 2005–2015 (Y. Matsuzawa, Personal Communication. 2016).

Although there is no nesting along the Pacific coast of Mexico, there has been substantial research on loggerhead turtles that describes their overall abundance and status (Peckham *et al.* 2007, Seminoff *et al.* 2004; 2014; Turner-Tomaszewicz *et al.* 2015). As mentioned below, fisheries bycatch and mortality from environmental phenomena such as harmful algal blooms are prevalent causes of mortality along the Pacific coast, with the hotspot for loggerhead presence and mortality found along the Pacific Coast of the Baja California Peninsula. Based on aerial surveys and satellite telemetry an estimated 43,000 loggerheads occur in this area (Peckham *et al.* 2007, Seminoff *et al.* 2014).

Fortunately, to curb these impacts, the government of Mexico established a new marine reserve in the region of Gulf of Ulloa, that implemented a fisheries time-area closure, an onboard observer program, video monitoring on a subset of artisanal boats, and a turtle mortality cap that, if exceeded, triggers a closure to the fishing season (CONAPESCA 2015). The status of these management actions in 2021 is unclear.

3.9.2 Nesting trends

Loggerheads nest on many beaches in Atlantic Mexico, however, the only current index beach for which long-term nesting trends are available is X´cacel on the coast of the State of Quintana Roo. At this site, the mean annual nesting abundance during the three initial years of data (2009–2011) was 336.3 nests/season and during the three final years of data (2019–2021) was 2,384.3 nests/season (Figure 3.9.3.1.). This reflects a substantial increase in nesting abundance, although there was a steep decline in nesting in 2021.

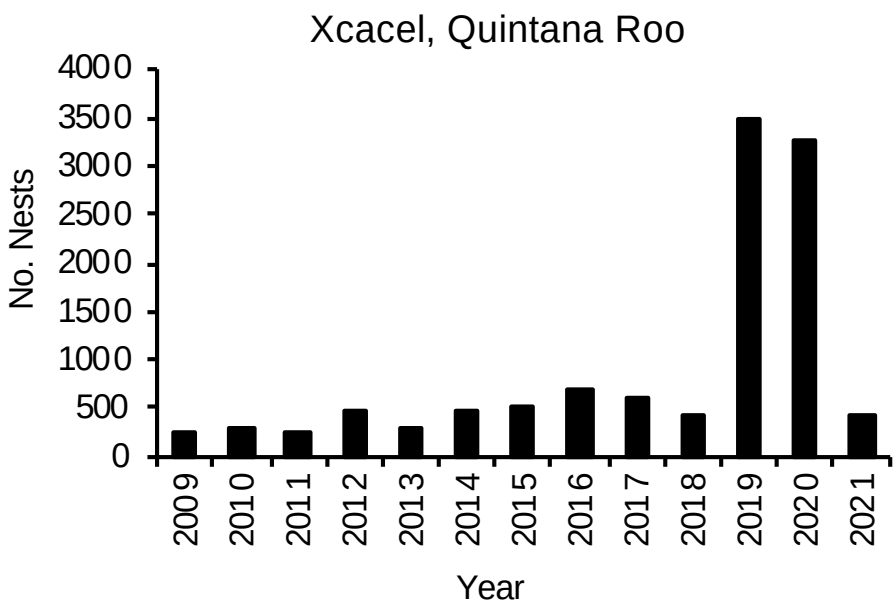

Figure 3.9.3.1. Annual nesting abundance for loggerhead turtles at the X´cacel index site in Quintana Roo, Mexico. This site has the highest quality and longest-running dataset for any of the monitored loggerhead nesting beaches in Mexico. Due to Covid impacts, the 2021 total includes multiple nesting beaches: X´cacel, Chemuyil, Xel Ha, Aventuras DIF (Previously Puerto Aventuras), Q. Roo.

3.9.3 Threats

Mexico's 2015 IAC report lists threats to loggerheads including pollution, artificial light, direct use, coastal development, and erosion or habitat loss. There is also incidental capture by shark, tuna, and shrimp fisheries, and Mexico has put observers in most fleets (IAC Annual Report 2015). Fisheries bycatch also takes place on the Pacific coast, impacting the North Pacific DPS (Peckham *et al.* 2007).

3.10. Netherlands (Caribbean)

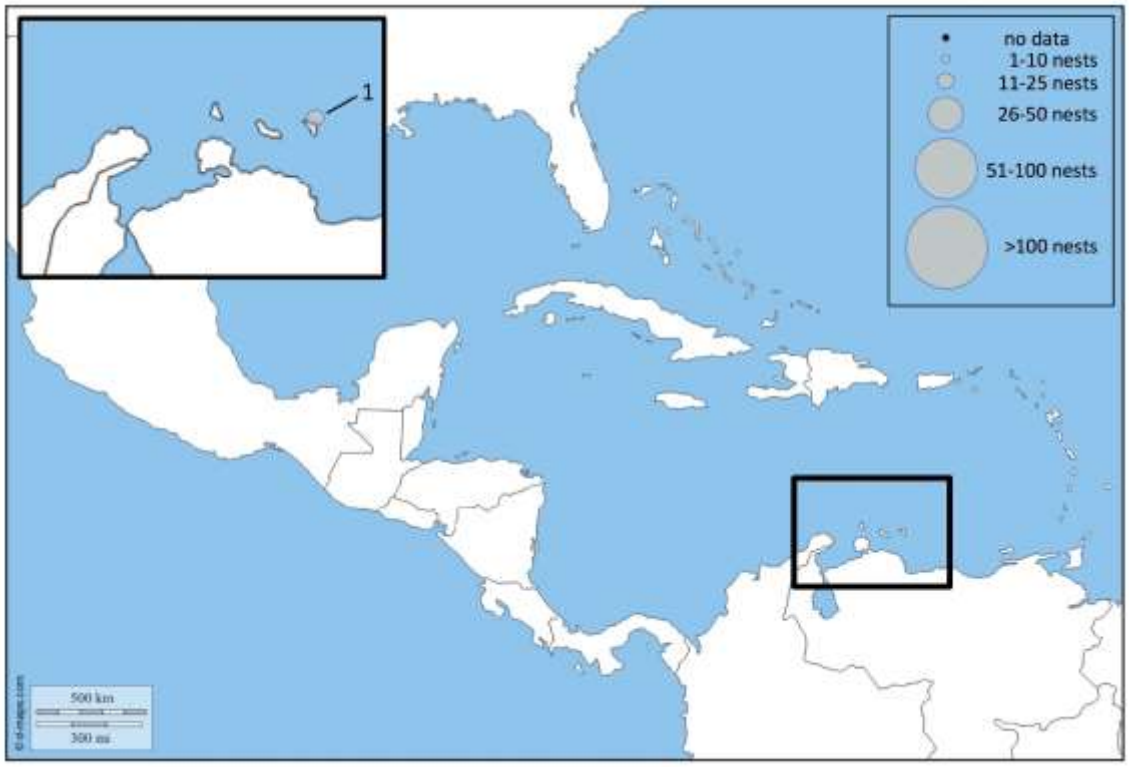

Figure 3.10.1. Map of loggerhead nesting index sites and abundance categories in Caribbean Netherlands. See following section for site number associated with each index beach.

3.10.1 Summary of index sites

One index site is used to represent Bonaire, and that is Klein Bonaire as seen on the map above.

3.10.2 Nesting abundance

There is no known nesting of loggerheads in St Eustatius or Saba. Bonaire monitors nesting on Klein Bonaire as well as beaches on the southern coast of Bonaire. These latter beaches are collectively known as the Southern Beaches. The most recent three years of data (2018–2020) for the primary index beach of Klein Bonaire is presented in Table 3.10.2.1. The average number of nests seen during this time period was 16.33 nests. The estimated total number of nesting females is 12 individuals, based on nest in inter-nest intervals. Data were provided by Sea Turtle Conservation Bonaire (STCB).

Table 3.10.2.1. Summary of loggerhead nest and female abundance at index nesting sites in Caribbean Netherlands

Nesting Site	Map Site	2018 Total Nests	2019 Total Nests	2020 Total Nests	Mean Annual Nests (2018-2020)	Mean Annual Nesting Females	Total Adult Females
Klein Bonaire	1	17	18	14	16.33	4.0	12.0

3.10.3 Nesting trends

The nesting trend for Bonaire, based on the index site on Klein Bonaire, appears to be relatively consistent from 2009–2020. After particularly high years in 2016 and 2017, the trend may now be decreasing. More long-term data are needed to create a reliable, informative trend.

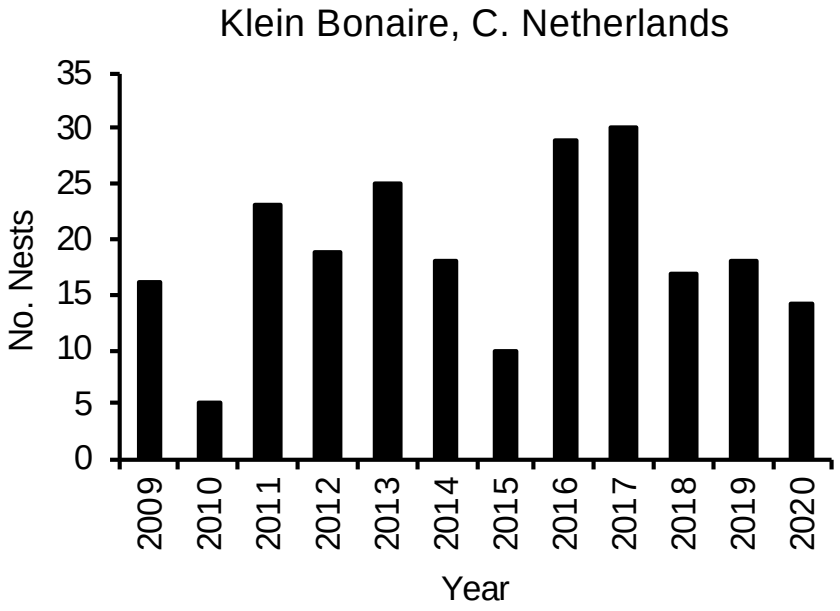

Figure 3.10.3.1. Annual nesting abundance for loggerhead turtles at the nesting index site on Klein Bonaire, Caribbean Netherlands.

3.10.4 Threats

Loggerhead nesting is not affected by anthropogenic activity. People are not allowed on Klein Bonaire after sunset and there is no camping permitted during the nesting season (K. Schut, Pers.com). Incidental capture occasionally happens, but longline, gillnet, and trawling fisheries are prohibited in Bonaire (J. Horrocks, pers. comm. 2016). To a lesser extent, and not in the Caribbean Netherlands, directed harvest of loggerheads has been reported in this region (Grenada; Grazette *et al.* 2007)."

3.11. Panama

Figure 3.11.1. Location of the only notable loggerhead nesting beach in Panama (Playa Chiriqui). This site is officially an Index Nesting Beach, but no data are available and nesting is thought to be extremely infrequent.

3.11.1 Loggerhead Presence

According to Panama IAC reports (2013 and 2014), loggerheads are present along their Caribbean coast, while only anecdotal evidence suggests they also are seen on the Pacific coast. No loggerhead nesting data for Panama were provided by IAC parties in the annual reports; however, Dow *et al.* (2007) report nesting in Playa Chiriquí (Map site 1) although no nesting numbers are provided. However, Meylan *et al.* (2013) report that, as mentioned by Dow *et al.* (2007), loggerhead nesting is very infrequent: From 2000–2011 only 6 reliable nesting records exist for Playa Chiriquí (n=2), Playa Bluff (n=1), and Playa Sixaola (n=3). In addition, Playa Large/Bastimentos was noted as a nesting site with no data by Dow *et al.* (2007). This site was also mentioned as a loggerhead tagging and foraging site in the 2014 IAC annual report for Panama. In terms of in-water presence, both Meylan *et al.* (2013) and Engstrom *et al.* (2002) report foraging of immature loggerheads on the Caribbean Panama coast.

3.11.2 Threats

Dow reported multiple forms of pollution, harassment by humans and dogs, and erosion or loss of habitat were frequent threats for sea turtles in general, not specific to loggerheads (2007). More threats are listed in the 2013 Panama IAC annual report, including light pollution, obstacles on beach, depredation of eggs and hatchlings, and egg collection by humans. More information is greatly needed to understand the status of loggerheads in Panama.

3.12. Peru

Figure 3.12.1. Map of South America depicting the range of loggerhead turtles occurring off of the coast of Peru (Based on range shown in Wallace *et al.* 2010).

3.12.1 Loggerhead Presence

Similar to Chile, the loggerhead turtles that forage off the coast of Peru originate from Australian and south-east Asia nesting beaches (Alava 2008). While in Peru, turtles forage in offshore waters and interact with a variety of fisheries (Mangel *et al.* 2011), although their presence is largely restricted to southern Peruvian waters. Mainly, they interact with artisanal longline fisheries in the south of Peru targeting sharks (*Prionace glauca* and *Isurus oxyrhynchus*) between April and October, and artisanal longline fisheries targeting dorado (*Coryphaena hippurus*) between November and March.

3.12.2 Threats

Long line fisheries off the coast of Peru, as well as other countries in the area are one of the greatest threats this DPS faces. Other threats include artificial lighting and pollution (IUCN Red List, 2015). In addition, bycatch mortality has also been reported around the

Peruvian islands of Lobos de Tierra and Lobos de Afuera, where a drift gillnet fishery for rays and sharks has been known to interact with loggerheads (IMARPE unpubl. data; J. Quiñones pers. comm. 2016). Recently, another threat with potential mortality has been detected, and is the interaction with abandoned longlines especially during winter, where loggerhead turtles (*Caretta caretta*) get entangled in longline pieces (ropes and corks). Two loggerheads entangled in this type of gear were recorded in July 2021 (J. Quiñones pers. comm. 2021)

There is progress on a bi-national project carried out with Chile, to report the occurrence of loggerhead turtles in artisanal longline fisheries at the ports of Matarani and Ilo (Peru) and in Arica, Iquique, and Tocopilla (Chile). The project will use structured interviews in a friendly format for the vessel's masters, to obtain adequate information that can be used to properly manage this South Pacific sub-population listed as "Critically Threatened" by the IUCN.

3.13. United States

Figure 3.13.1. Map of loggerhead nesting index sites and abundance categories in the United States. See following section for site number associated with each index beach.

3.13.1 Summary of index sites

For the sake of space, the individual index beaches are not listed here, but can be found at www.myFWC.com or on www.seaturtle.org. The United States contain the majority of loggerhead nesting for the IAC region. Data from the following states are included in this report: Florida (FL), Georgia (GA), South Carolina (SC), and North Carolina (NC). Loggerhead nesting also occurs from Alabama to Texas and further north on the east coast, but in lower numbers.

3.13.2 Nesting abundance

Nesting data for loggerheads in the United States are from the Florida index beaches, as well as index sites in Georgia, South Carolina, and North Carolina. In the previous version of this report, Florida data were separated between the main Florida index sites and the Florida Panhandle. However, U.S. now reports all Florida data at the statewide level for each year. In addition, starting in 2022 the U.S. started reporting for nesting data for loggerheads in Georgia and the Carolinas. Florida overall consistently has the most loggerhead nests of the United States. South Carolina has the second highest annual loggerhead nest numbers, followed by Georgia and then North Carolina.

Table 3.13.2.1. Summary of loggerhead nest and female abundance at index nesting sites in the United States

Index Nesting Beach/State	Map Site	2020 Total Nests	2021 Total Nests	2022 Total Nests	Mean Annual Nests (2020-2022)	Mean Annual Nesting Females	Total Adult Females
Florida	1,2	106,656	105,185	96,666	102,836	25,082	75,246
Georgia	3	3950	2786	2493	3076	750	2251
North Carolina	4	2293	1335	1448	1692	413	1238
South Carolina	5	8781	5550	5639	6657	1624	4871
TOTAL		**121,680**	**114,856**	**106,246**	**114,261**	**27,868**	**83,605**

3.13.3 Nesting trends

Nesting data for Florida have been reported in the IAC Annual Reports since 2009. Over this 15-year duration, the Florida loggerhead population has modestly increased, with a peak in nesting in 2017. Due to the short duration of data availability for Georgia, South Carolina, and North Carolina, nesting trends are not yet available for these sites.

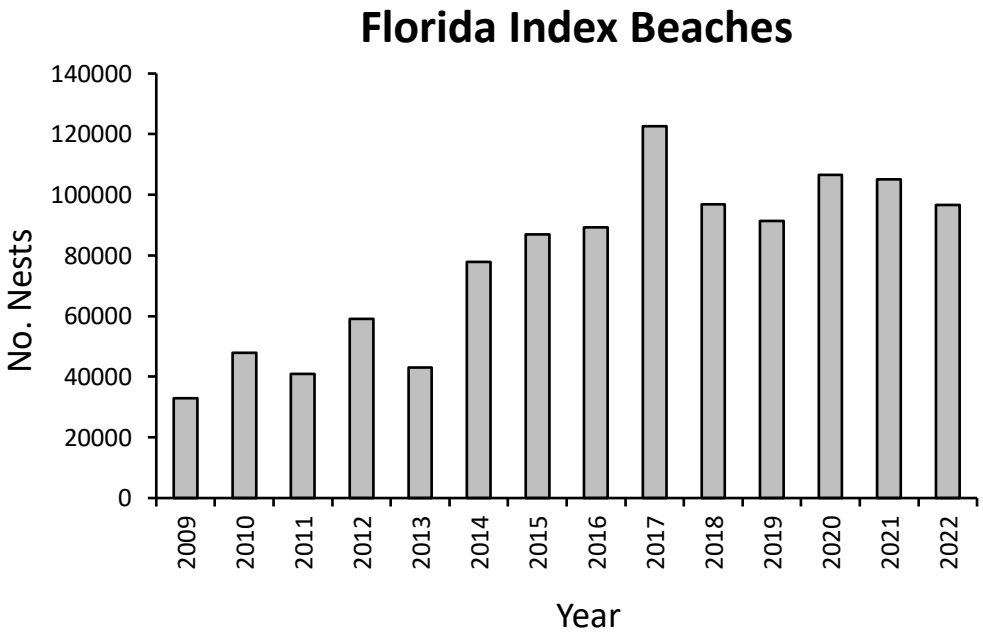

Figure 3.13.3.1. Annual nesting abundance for loggerhead turtles at the Florida index beaches in the United States. Nesting assemblages in Georgia, South Carolina, and North Carolina are also index sites (established in 2022), however, no long-term data are available for trend analysis at these sites.

3.13.4 Threats

Artificial light is a major threat for nesting and hatchling turtles along highly developed coastlines. Lighting ordinances and retrofits reduce this threat. Artificial lighting is less of a threat along those nesting beaches in protected areas such as Cape Canaveral National Seashore Other threats include coastal development, boat strikes or fishing line entanglements, and especially fisheries bycatch, particularly in the Gulf of Mexico (Finkbeiner 2011, IAC Annual Report 2015).

3.14. Uruguay

Figure 3.14.1. Map of distribution of loggerheads from the Southern Atlantic Regional Management Unit, showing the range for the species in waters of Uruguay (Based on range shown in Wallace *et al.* 2010).

3.14.1 Loggerhead Presence

Loggerheads are found using the Uruguayan territorial sea as foraging and developmental area for the species ((Barceló et al. 2013), (Vélez-Rubio et al. 2013), (Laporta et at. 2012). SWOT showed a map of satellite tag activity that indicated this area is a very popular foraging area for many turtles, loggerheads in particular (SWOT Vol. 11, pp. 24-27). Research being done includes tagging foraging turtles, collecting tissue samples and necropsies (IAC Annual Report 2014).

3.14.2 Threats

In Uruguay, just like in Argentina, sea turtles are found in areas off shores and are mainly threaten by incidental bycatch and pollution, which is currently under research. López-Mendilaharsu et al.(2020), in the framework of ASO-Sea Turtle Network, carried out a multi-threat's analysis for the loggerhead turtles in the Southeast Atlantic of Brazil, Uruguay and Argentina, showing that incidental bycatch in fisheries is considered the

most significant threat to loggerhead in these waters. Uruguay has an On-board Observer Program from the National Directory of Aquatic Resources (DINARA for its acronym in Spanish) which collects information regarding incidental bycatch of sea turtles and other species in the industrial fleet.

According to IAC Annual Reports submitted by Uruguay in 2021, 2022 and 2023, although this on-board observer programs it is still active, at present the program it is not collecting information on the coastal trawling industrial fleet, one of the fisheries in Uruguay´s waters that is causing the most impact with loggerheads in the Southwest Atlantic.

In addition, it is worth mentioning that according to the IAC Annual reports above mentioned, Uruguay no longer has longline fisheries fleet in the country.

3.15. Venezuela

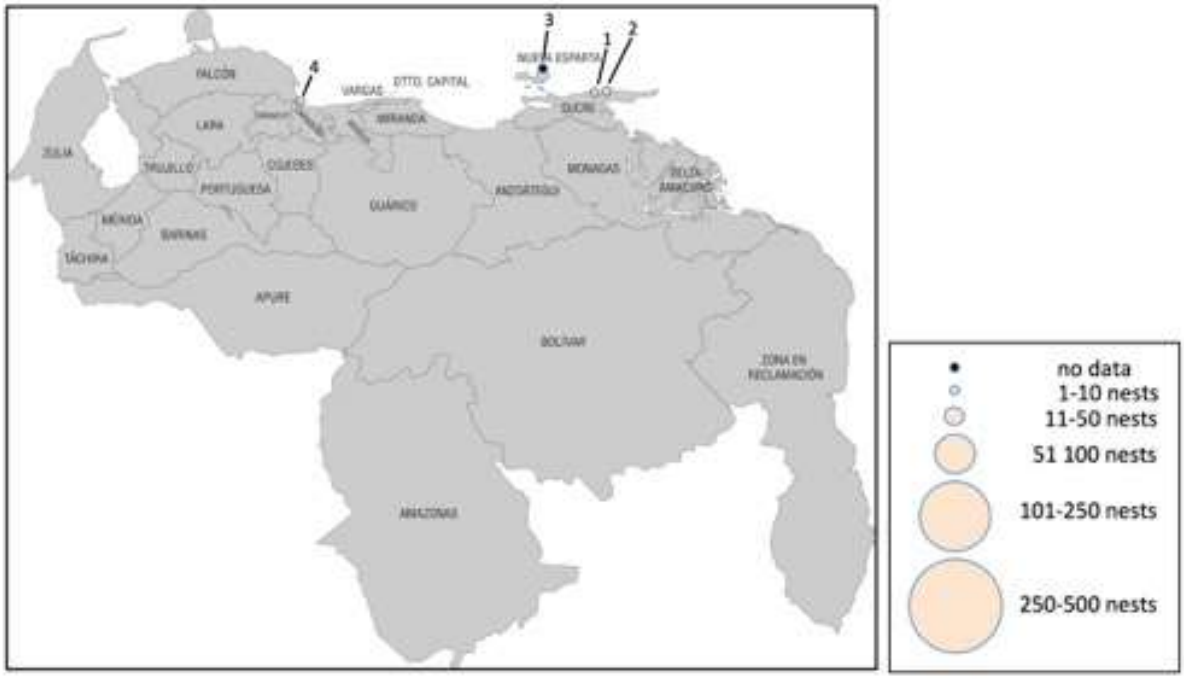

Figure 3.1.1. Map of loggerhead nesting sites along the coast of Venezuela. See Table 3.15.2.1 for specific map sites. (Map provided by the Government of Venezuela)

3.15.1 Summary of index sites

It would be important to clarify the loggerhead nesting sites that are considered index nesting beaches currently. Prior to 2022, Querepare and Cipara were the two primary index sites in Venezuela. Starting in 2022, three additional index beaches were added by Venezuela (Parque Nacional Archipelago Los Roques, Playa Cuyagua, and Parque Nacional Henri Pittier-Map, Site 4).

3.15.2 Nesting abundance

Nesting abundance data are only available for Querepare (2014-2018) and Cipara (2014, 2016-2018). Despite the addition of the three new index beaches, no nesting data are available for these sites. The available information indicates low nesting numbers for Querepare (from 1-3 nests each year) and slightly higher numbers for Cipara, with a maximum of 25 nests in 2018 (Table 3.15.2.1).

Table 3.15.2.1. Summary of available loggerhead nest and female abundance data at two index nesting sites in Venezuela. As of 2022, three additional index beaches were added by Venezuela (Parque Nacional Archipelago Los Roques, Playa Cuyagua, and Parque Nacional Henri Pittier), but no information has been reported for these sites in the IAC annual reports.

Index Beach/State	**Map Site**	**2016 Total Nests**	**2017 Total Nests**	**2018 Total Nests**	**Mean Annual Nests**	**Mean Annual Nesting Females**	**Total Adult Females**
Querepare	1	3	2	1	2	0.5	1.5
Cipara	2	13	7	25	15	3.7	11.0
TOTAL		**16**	**9**	**26**	**17**	**4.1**	**12.4**

3.15.3 Threats

No industrial trawling fleets are allowed in Venezuelan waters, but entanglement can occur sporadically (IAC Annual Report 2014). According to the National Strategy for Biological Diversity Conservation 2010–2020 the following were identified as direct causes for loss of biological diversity in the country: ecosystems degradations and fragmentation; alien species introductions, establishment and invasion; and unsustainable use of biological diversity.

4. Summary for Entire IAC Region

4.1 Summary of index sites

Among the seven IAC nations that are known to host loggerhead nesting activity, there are a total of 20 different index nesting beaches, although not all of these sites have available data presently. Among these, there are long-term (10+ years) data for 10 sites (1 in Belize, 6 in Brazil, 1 in Caribbean Netherlands, 1 in Mexico, and 1 in the US). The current loggerhead index nesting beaches for each IAC country are listed below (Table 4.1.1). In the case of the United States, rather than index sites *per se*, data are summarized by index state/region (Florida, Georgia, North Carolina, South Carolina). Each of these states are comprised of a series of nesting beaches that amount to more than 300 beaches among all four index regions. Complete lists of United States index beaches can be found at www.seaturtle.org or www.myFWC.org.

Table 4.1.1. IAC index nesting beaches

Belize (2)	Ambergris Caye, Gales Point Manatee
Brazil (6)	Comboios, Povoação, Guarajuba, Interlagos, Praia do Forte, Farol
Mexico (1)	X´cacel
Netherlands Caribbean (1)	Klein Bonaire
Panama (1)	Playa Chiriquí
USA (4)	Florida index beaches, Georgia, South Carolina, and North Carolina totals (over 300 beaches total)
Venezuela (5)	Querepare, Cipara, Parque Nacional Archipiélago Los Roques, Playa Cuyagua, and Parque Nacional Henri Pittier

4.1.1 Nesting abundance

We present nesting abundance in terms of total females in the population. This is derived from the mean annual nest count for each beach divided by the mean annual of nests per female per season (4.1 nests/female/season; in Casale *et al.* 2015), which arrives at a total number of females nesting in each season. This total annual female value is then multiplied by the mean internesting frequency of 3 yrs. (in Casale *et al.* 2015) to estimate the total number of females in the population. Recall that only about one third of the adult female population nests in any given nesting season, thus the need to extrapolate beyond the female count for a single year.

Based on these calculations (Table 4.1.2.1 below), the total estimated adult female abundance in IAC nations is 88,428 individuals). This is substantially higher than the total estimated abundance in the 2016 IAC loggerhead assessment (39,223 adult females).

The increase is likely driven by 1) the inclusion of additional index sites (eg, US, Venezuela) in the new estimate, and 2) the increase in loggerhead nesting in Florida and Brazil.

Loggerheads in IAC countries represent two regional management units (RMUs), the Northwest Atlantic and Southwest Atlantic. The Northwest Atlantic RMU includes loggerheads from the Caribbean Netherlands, U.S., Mexico, and Belize, and consists of ~85,386 adult females among all nesting beach populations. The Southwest Atlantic RMU, which is comprised of nesting beaches in Brazil and Venezuela, has ~3,042 females in the population. Florida is by far the largest aggregation of nesting females for the Northwest Atlantic population, and Brazil is the primary location for nesting activity in the Southwest Atlantic.

Table 4.1.2. Recent abundance of nesting loggerheads within IAC countries. Data are presented for the most recent 3-year (= 1 remigration interval) range at each site. Total females are calculated based on these values. * = partial data

Country	2016 Total Nests	2017 Total Nests	2018 Total Nests	2019 Total Nests	2020 Total Nests	2021 Total Nests	2022 Total Nests	Mean Annual Nests[+] (Most recent 3 yrs.)	Mean Annual Nesting Females [++] (4.1)	Total Adult Females
Belize	21	49	29	72	37	11*	30	33	8.0	24.1
Brazil				4519	4784	3121		4141.3	1010.1	3030.2
Mexico				3477	3258	418		2384.3	581.5	1744.6
Caribbean Netherlands			17	18	14			16.33	4.0	12.0
USA					121,680	114,856	106,246	114,261	27,868	83,605
Venezuela	16	9	26					17	4.1	12.4
TOTAL								120,853	29,476	88,428

[+] mean annual nests calculated as the mean of nests deposited during the three most recent years for which nesting data are available. This is based on a mean inter-nesting interval of 3 yrs. (Schroeder *et al.* 2003)
[++]mean annual females is calculated at the mean annual nests divided by the mean nests per female per season (4.1; Schroeder *et al.* 2003)

4.1.2 Nesting trends

Data have been gathered from a total of 17 index nesting beaches among these nations, with 10 of these sites having long-term data of 10 years or more. Based on the most recent 3 years of data for each site, there are a mean of 120,853 total nests are deposited each year, which equates to 29,476 nesting females per year. Long-term (>10 yrs.) time series data on nesting are available for 1 index beach in Belize (stable to decreasing trend), 6 in Brazil (stable to decreasing trends), 1 in Caribbean Netherlands (possibly decreasing trend), 1 in Mexico (stable to increasing trend), and 1 in United States (stable trend). In addition to turtles originating from IAC nation nesting beaches, loggerheads

inhabiting waters along the Pacific coast of the Americas come from nesting stocks in Japan (foraging in Mexico) and Australia / New Caledonia (Peru and Chile). Recent nesting data for these source populations are unavailable; however, the Japanese stock is thought to be stable-to-increasing, whereas Australia stocks are thought to be decreasing (IUCN, 2016). No information is available from New Caledonia.

4.1.3 Threats

Information on threats to loggerhead turtles in IAC nations have been gathered from IAC Annual Reports, correspondence with country informants, and the published literature. For the latter, we relied on data presented in the IUCN Red List Assessment of loggerhead turtles (Casale *et al.* 2015), the U.S. Endangered Species Act Biological Review of Loggerheads (Conant *et al.* 2008), and the paper by Wallace *et al.* (2011) entitled "Global Conservation Priorities for Marine Turtles". In this report we provide a general summary of the types of threats; for more detailed information please refer to the aforementioned assessment documents. Threats to loggerheads are similar across the entire IAC region and include pollution, artificial lighting, fisheries bycatch, harvest, vessel strikes, coastal development, and habitat loss (Table 4.1.4.1). The most ubiquitous threats are fisheries bycatch and coastal development. Impacts from climate change are also thought to occur across the IAC region, although their effects are often subtle and difficult to quantify. It should be noted that while these threats impact loggerheads, they are also thought to affect other species of sea turtles that reside within these IAC nations.

Table 4.1.3.1. Overview of threats facing nesting loggerhead turtles in IAC countries that have loggerheads present. (●● = present, ● = present but minor impact)

Country/DPS	**Marine Debris and Other Pollution**	**Artificial Light**	**Fisheries Bycatch**	**Direct Take for Human Consumption**	**Coastal Development**	**Habitat Loss**
Brazil			●●		●●	
Belize	●●	●●	●●		●●	●●
Mexico	●●	●●	●●	●●	●●	●●
USA		●	●●	●●	●●	
Panama (Car.)	●●		●		●●	
Venezuela				●●	●●	●●
Caribbean Netherlands		●●	●		●●	
Honduras	●●		●●	●●	●●	●●

5. Conservation Recommendations

Based on this summary report, the IAC Scientific Committee in consultation with Consultative Committee of Experts will identify the main actions for the IAC Parties to undertake to improve the conservation status of all loggerhead turtles. However, as a preliminary list of conservation actions we recommend the following:

International Conservation and Partnerships

- Establish and strengthen partnerships with governmental and NGO groups in Japan and Australia to promote loggerhead conservation.
- Strengthen collaboration with CMS to jointly implement their 2014 document: Single Species Action Plan for the Loggerhead Turtle (*Caretta caretta*) in the South Pacific Ocean.

Nesting Beaches Conservation and Monitoring in IAC countries

- Maintain monitoring efforts at all IAC loggerhead index nesting beaches so as to build a dataset that will eventually enable long-term trend analysis for all nesting sites.
- Work among IAC parties and NGO partners to promote nesting beach protection at loggerhead nesting beaches in each respective IAC nation
- Promote “sea turtle-friendly” (artificial lighting that has less of an impact to sea turtles through shielding, long wavelengths and low level) nesting beach lighting ordinances in each of the nations that have been impacted by coastal development, when and where appropriate.
- For nesting beach monitoring, it is important to also focus on smaller nesting assemblages to understand the trends in these areas
- Conduct an assessment of loggerhead nesting status in IAC Nations (i.e. an update of this document) every 5 years.

Direct Harvest and Fisheries Bycatch

- Ensure that loggerhead directed take is eliminated from all areas currently identified as having this problem; this includes in-water and nesting beach harvest.
- Conduct robust bycatch analysis in all nations identified as having this threat to pinpoint the gear types and fleets that are having the greatest impact; work with local partners to promote bycatch reduction technologies in these areas.

5.1. Lessons Learned and Recommendations

During the drafting of this loggerhead evaluation, there are a number of lessons learned that warrant mention in the current report. These take-home messages and associated recommendations include:

1. Data presented in IAC Annual Reports are of utmost importance for evaluations such as this. We encourage all IAC nations to submit their annual reports with nesting abundance information provided for each national index site.

2. When providing data on nesting activity, it is important to include the units of measure (i.e., nests, females). During the drafting of this report, there were several instances when the data type was unclear.
3. When providing data on nesting activity, if there is no nesting at a given index beach for any year, it is important to input a '0' rather than leave the box blank. On several occasions we were unaware if blank spaces were due to lack of inputting data or due to no nesting that year.
4. For annual IAC reporting, attempt to acknowledge how representative index sites are of the overall trends for a region.
5. For determination of future index sites, it is worthy to highlight areas that used to have nesting but no longer have nesting.
6. It is important to include nesting information for even the smallest sites. While perhaps small in comparison to other nesting beaches, data from these sites can also provide important trend information when evaluated over long-terms.
7. The IAC region lacks long-term data for most sites. Therefore, it is essential that we continue to collect annual nesting data so that someday in the medium term we are able to evaluate nesting trends.
8. We recommend that the nesting season from which the data came is indicated on the nesting table of the IAC Annual Report. With nesting seasons starting and ending at different times of the year, we found some annual reports submitted by IAC Parties to have data for the previous nesting season (i.e. a 2015 report including data from 2014).
9. The update of this document is indicated in element 3 of the Loggerhead Resolution CIT-COP7-2015-R3 "Request to the IAC Scientific Committee to develop a summary report of the status of all loggerhead populations in the IAC area every four years". The next update of the Technical Document will be 2027 and it will be coordinated by the delegates of the Scientific Committee of the United States and Brazil.

6. Acknowledgements

We give special thanks to Veronica Caceres for assistance throughout this report writing process. We gratefully acknowledge the following individuals for assistance with various aspects of this report: Julia Horrocks, Hedelvy Guada, Victoria González Carman, Haydeé Medina, Ernesto Pulgar, Luz Helena Rodríguez, Laura Sarti, and the entire IAC Scientific Committee. We also thank all the IAC Scientific Committee country representatives for help with revision of this report and assistance with provision of additional data and personal communications used herein.

7. Literature Cited

Alava, J.J. 2008. Loggerhead Sea Turtles (*Caretta caretta*) in Marine Waters off Ecuador: occurrence, Distribution and Bycatch from the Eastern Pacific Ocean. Marine Turtle Newsletter 119:8-11.

Allen, C.D., G.E. Lemons, T. Eguchi, R.A. LeRoux, C.C. Fahy, P.H. Dutton, S.H. Peckham, J.A. Seminoff. 2013. Migratory origin of loggerhead turtles (*Caretta caretta*) in the southern California bight as inferred by stable isotope analysis and satellite telemetry: implications for fisheries management. Marine Ecology Progress Series 472:275-285.

Álvarez-Varas, R., R. Berzkins, K. Bilo, J. Chevalier, D. Chevalier, B. De Thoisy, A. Fallabrino, M. Garcia Cruz, S. Kelez, M. Lopez-Mendilaharsu, A. Marcovaldi, R. B. Mast, C. Medrano, C. Miranda, M. A. Nalovic, L. Prosdocimi, J. M. Rguez-Baron, A. Santos, L. Soares, J. Thome, F. Vallejo, G. Velez-Rubio. 2011. Sea Turtles of South America. SWOT11_p14-27_South America.

Avens, L., L.R. Goshe, M. Pajuelo, K.A. Bjorndal, B. MacDonald, G. Lemons, A.B. Bolten, and J.A. Seminoff. 2013. Complementary skeletochronology and stable isotope analyses offer new insight into juvenile loggerhead sea turtle (*Caretta caretta*) oceanic stage duration and growth dynamics. Marine Ecology Progress Series 491: 235–251.

Avens, L., L.R. Goshe, L. Coggins, M.L. Snover, M. Pajuelo, K.A. Bjorndal, A.B. Bolten. 2015. Age and Size at maturation- and adult-stage duration for loggerhead sea turtles in the western North Atlantic. Marine Biology 162: 1749-1767

Avens, L. and M.L. Snover. 2013. Age and Age Estimation in Sea Turtles. In: The Biology of Sea Turtles, Volume III. Wyneken, J., K. Lohmann, J. Musick, eds. CRC Press,

Barceló C, Domingo A, Miller P, Ortega L, Giffoni B, Sales G, McNaughton L, Marcovaldi M, Heppell S, Swimmer Y (2013) High-use areas, seasonal movements and dive patterns of juvenile loggerhead sea turtles in the Southwestern Atlantic Ocean. Marine Ecology Progress Series 479:235-250

Bjorndal, K.A. 1997. Foraging Ecology and Nutrition of Sea Turtles. In: The Biology of Sea Turtles. Lutz, P. and J. Musick, eds. CRC Press.

Bolten, A.B. 2003. Active Swimmers - Passive Drifters: The Oceanic Juvenile Stage of Loggerheads in the Atlantic System. In: Loggerhead Sea Turtles. Bolten and Witherington, eds. Smithsonian Books, 2003.

Bolten, A.B. and B.E. Witherington, eds. 2013. Loggerhead Sea Turtles.. Smithsonian Books.

Bolten, A.B., L.B. Crowder, M.G. Dodd, S.L. Macpherson, J.A. Musick, B.A. Schroeder, B.E. Witherington, K.J. Long, and M.L. Snover. 2010. Quantifying multiple threats to

endangered species: an example from loggerhead sea turtles. Frontiers in Ecology and the Environment.

Brongersma, L.D. 1961. Notes upon some sea turtles. Zoologische Verhandelingen 51:1-45.

Carthy, R.R., A.M. Foley, and Y. Matsuzawa. 2003. Incubation environment of loggerhead turtle nests: effects on hatching success and hatchling characteristics. Pages 144-153 *in* Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

Casale *et al.* 2015. IUCN Red List Review of Loggerhead Sea Turtles.

Conant, T.A., P.H. Dutton, T. Eguchi, S.P. Epperly, C.C. Fahy, M.H. Godfrey, S.L. MacPherson, E.E. Possardt, B.A. Schroeder, J.A. Seminoff, M.L. Snover, C.M. Upite, and B.E. Witherington. 2009. Loggerhead sea turtle *(Caretta caretta)* 2009 status review under the U.S. Endangered Species Act. Report of the Loggerhead Biological Review Team to the National Marine Fisheries Service. 222 pages.

CONAPESCA. 2015. Zona de Refugio Pesquero y Medidas Para Reducir la Interacción con Tortugas Marinas en la Costa Occidental de Baja California Sur. Reporte Internacional

CMS: Convention on the Conservation of Migratory Species. http://www.cms.int/en/species/caretta-caretta. Accessed August 2016.

Dahlen, M.K., R. Bell, J.I. Richardson, and T.H. Richardson. 2000. Beyond D-0004: Thirty- four years of loggerhead (*Caretta caretta*) research on Little Cumberland Island, Georgia, 1964-1997. Pages 60-62 *in* Abreu-Grobois, F.A., R. Briseno-Duenas, R. Marquez, and L. Sarti (compilers). Proceedings of the Eighteenth International Sea Turtle Symposium. NOAA Technical Memorandum NMFS-SEFSC-436.

Deraniyagala, P.E.P. 1933. The loggerhead turtles (Carettidae) of Ceylon. Ceylon Journal of Science (B) 18:61-72.

Deraniyagala, P.E.P. 1939. The tetrapod reptiles of Ceylon. Volume 1. Testudinates and crocodilians. Colombo Museum Natural History Series, Colombo, Ceylon. 412 pages.

Dodd, C.K., Jr. 1988. Synopsis of the biological data on the loggerhead sea turtle *Caretta* (Linnaeus 1758). U.S. Fish and Wildlife Service Biological Report 88(14). 110 pages.

Donoso, M and P.H. Dutton. 2010. Sea turtle bycatch in the Chilean pelagic longline fishery in the southeastern Pacific: Opportunities for conservation. Biological Conservation 143: 2672–2684.

Dow, W., K.A. Eckert, M. Palmer and P. Kramer. 2007. An Atlas of Sea Turtle Nesting Habitat for the Wider Caribbean Region. The Wider Caribbean Sea Turtle Conservation Network and The Nature Conservancy. WIDECAST Technical Report No. 6. Beaufort, North Carolina.

Eckert, S.A., J.E. Moore, D.C. Dunn, R.S. van Buiten, K.L. Eckert, and P.N. Halpin. 2008. Modeling loggerhead turtle movement in the Mediterranean: importance of body size and oceanography. Ecological Applications 18(2):290-308.

Engstrom, T.N., P.A. Meylan, A.B. Meylan. 2002. Origin of juvenile loggerhead turtles (*Caretta caretta*) in a tropical developmental habitat in Caribbean Panama. Animal Conservation 5:125-133.

Finkbeiner, E.M., B.P. Wallace, J.E. Moore, R.L. Lewison, L.B. Crowder, A.J. Read. 2011. Cumulative estimates of sea turtle bycatch and mortality in USA fisheries between 1990 and 2007. Biological Conservation 144: 2721.

Florida Fish and Wildlife Conservation Commission. (n.d.). Consulta en Junio de 2016 en http://www.myFWC.com/.

Grazette, S., J.A. Horrocks, P.E. Phillip, and C.J. Isaac. 2007. An assessment of the marine turtle fishery in Grenada, West Indies. Oryx 41:330-336.

González Carman V, Álvarez K, Prosdocimi L, Inchaurraga MC, Dellacasa RF, Faiella A, Echenique C, González R, Andrejuk J, Mianzan H, Campagna C, Albareda DA (2011) Argentinian coastal waters: A temperate habitat for three species of threatened sea turtles. Marine Biology Research 7:500-508

González Carman V, Bruno I, Maxwell S, Álvarez K, Albareda D, Acha EM, Campagna C (2016) Habitat use, site fidelity and conservation opportunities for juvenile loggerhead sea turtles in the Río de la Plata, Argentina. Marine Biology 163:20

González Carman V, Denuncio P, Vassallo M, Berón MP, Álvarez KC, Rodriguez-Heredia S (2021) Charismatic Species as Indicators of Plastic Pollution in the Río de la Plata Estuarine Area, SW Atlantic. Frontiers in Marine Science 8

Harrison, A.-L. and K.A. Bjorndal. 2006. Connectivity and wide-ranging species in the ocean. Pages 213-232 *in* Crooks, K.R. and M.A. Sanjayan (editors). Connectivity Conservation. Cambridge University Press, Cambridge.

Hamann, M., R.L. Kamrowski, and T. Bodine. Assessment of the Conservation Status of the Loggerhead Sea Turtle in the Indian Ocean and South-East Asia. IOSEA, 2013.

Heppell, S.S., M.L. Snover, and L.B. Crowder. 2003a. Sea Turtle Population Ecology. In: The Biology of Sea Turtles, Volume II. Lutz, P., J. Musick, and J. Wyneken, eds. CRC Press.

Heppell, S.S., L.B. Crowder, D.T. Crouse, S.P. Epperly, and N.B. Frazer. 2003b. Population Models for Atlantic Loggerheads: Past, Present, and Future. In: Loggerhead Sea Turtles. Bolten and Witherington, eds. Smithsonian Books, 2003.

Horrocks, J. and S. Willis. Personal communication. 2016.

IAC annual reports (Argentina 2015, 2016; Belize 2014, 2015, 2016; Brazil 2013-2016; Caribbean Netherlands 2014, 2016 ; Venezuela 2012, 2014, 2015, 2016; USA 2015, 2016; Mexico 2014-2016; Honduras 2013-2016; Costa Rica 2014, 2015, 2016. Chile 2015.

IAC. 2013. Selecting Index Nesting Beaches in the IAC Region and Data Collection Guidelines. Inter-American Convention for the Protection and Conservation of Sea Turtles, CIT-CC10-2013-Tec.5.

IAC. 2015. Resolution on the Conservation of the Loggerhead Sea Turtle (*Caretta caretta*). IAC, 7th Conference of Parties, Mexico City. June 2015. CIT-COP7-2015-R3.

IMARPE (Instituto del Mar del Peru). 2015. unpubl. data

Jones, T.T., and J.A. Seminoff. 2013. Feeding Biology: Advances from Field-Based Observations, Physiological Studies, and Molecular Techniques. In: Musick, J., J. Wyneken, and K. Lohman (Eds.), Biology of the Sea Turtles, Volume 3. CRC Press, Boca Raton, FL., pp 211-248.

Kamezaki, N., Y. Matsuzawa, O. Abe, H. Asakawa, T. Fujii, K. Goto, S. Hagino, M. Hayami, M. Ishii, T. Iwamoto, T. Kamata, H. Kato, J. Kodama, Y. Kondo, I. Miyawaki, K. Mizobuchi, Y. Nakamura, Y. Nakashima, H. Naruse, K. Omuta, et. al. 2003. Loggerhead Turtles Nesting Japan. In: Loggerhead Sea Turtles. Bolten and Witherington, eds. Smithsonian Books, 2003.

Laporta M., P. Miller & A. Domingo. 2012. Captura incidental de tortugas marinas en la pesquería de arrastre Uruguaya. In Zaldua-Mendizabal, N., Egaña-Callejo, A. (Editors). 2012. Marine turtles of the North East Atlantic. Contributions for the First Regional Conference. Munibe Monographs. Nature Series 1. Aranzadi Society of Sciences. San Sebastian. P. 43-50

Lewison, R., B. Wallace, J. Alfaro-Shigueto, J. C. Mangel, S. M. Maxwell, and E. L Hazen. 2013. Fisheries Bycatch of Marine Turtles: Lessons Learned from Decades of Research and Conservation. In: The Biology of Sea Turtles, Volume III. Wyneken, J., K. Lohmann, J. Musick, eds. CRC Press.

Limpus, C.J., P. Reed, and J.D. Miller. 1983. Islands and turtles: the influence of choice of nesting beach on sex ratio. Pages 397-402 *in* Baker, J.T., R.M. Carter, P.W.

Sammarco, and K.P. Stark (editors). Proceedings of the Inaugural Great Barrier Reef Conference, James Cook University Press, Townsville, Queensland, Australia.

Limpus, C.J. and D.J. Limpus. 2003. Loggerhead turtles in the equatorial and southern Pacific Ocean: a species in decline. Pages 199-209 *in* Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

Lohmann, K.J. and C.M.F. Lohmann. 2003. Orientation mechanisms of hatchling loggerheads. Pages 44-62 *in* Bolten, A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

López-Mendilaharsu, M., B., Giffoni, D. Monteiro, L. Prosdocimi, G.M. Vélez-Rubio, A. Fallabrino, A. Estrades, A. Santana dos Santos, P.H. Lara, T. Pires, M. Tiwari, A.B. Bolten and M.A. Marcovaldi. 2020. Multiple-threats analysis for Loggerhead Sea turtles in the southwest Atlantic Ocean. Endangered Species Research 41:183–196.

Mangel, J.C., J. Alfaro-Shigueto, M.J. Witt, P.H. Dutton, J.A. Seminoff, and B.J. Godley. 2011. Post-capture movements of loggerhead turtles in the southeastern Pacific Ocean assessed by satellite tracking. Marine Ecology Progress Series 433:261-272

Mansfield, K.L. 2006. Sources of mortality, movements and behavior of sea turtles in Virginia. Unpublished Ph.D. dissertation. Virginia Institute of Marine Science, Gloucester Point, Virginia. 343 pages.

Marcovaldi, M.A., M.H. Godfrey, and N. Mrosovsky. 1997. Estimating sex ratios of loggerhead turtles in Brazil from pivotal incubation durations. Canadian Journal of Zoology 75:755- 770.

Marcovaldi, M.A. and M. Chaloupka. 2007. Conservation status of the loggerhead sea turtle in Brazil: an encouraging outlook. Endangered Species Research 3(2)133-143.

Matsuzawa, Y. Personal Communication. 2016

McGehee, M.A. 1990. Effects of moisture on eggs and hatchlings of loggerhead sea turtles (*Caretta caretta*). Herpetologica 46(3):251-258.

Meylan, A.B., P.A. Meylan, and C. Ordonez Espinosa. 2013. Sea turtles of Bocas del Toro province and the Comarca Ngobe-Bugle, Republic of Panama. Chelonian Conservation and Biology 12(1):17-33.

Miller, J. D. 1997. Reproduction In Sea Turtles. In: The Biology of Sea Turtles. Lutz, P. and J. Musick, eds. CRC Press.

Miller, J.D., C.J. Limpus, and M.H. Godfrey. 2003. Nest site selection, oviposition, eggs, development, hatching, and emergence of loggerhead turtles. Pages 125-143 *in* Bolten,

A.B. and B.E. Witherington (editors). Loggerhead Sea Turtles. Smithsonian Books, Washington D.C.

Mrosovsky, N. 1980. Thermal biology of sea turtles. American Zoologist 20:531-547.

Mrosovsky, N. 1988. Pivotal temperatures for loggerhead turtles from northern and southern nesting beaches. Canadian Journal of Zoology 66:661-669.

Mrosovsky, N. and C.L. Yntema. 1980. Temperature dependence of sexual differentiation in sea turtles: implications for conservation practices. Biological Conservation 18:271-280.

Peckham SH, Maldonado Díaz D, Walli A, Ruiz G, Nichols WJ, Crowder L (2007) Small-scale fisheries bycatch jeopardizes endangered Pacific loggerhead turtles. PLoS ONE 2:e1041

Pritchard, P.C.H. 1979. Encyclopedia of turtles. T.F.H. Publications, Neptune, New Jersey. 895 pages.

Pritchard, P.C.H. and P. Trebbau. 1984. The turtles of Venezuela. Society for the Study of Amphibians and Reptiles Contributions to Herpetolology, Number 2.

Quinones, J. personal communication. 2016

Sarti, L. Personal communication. 2016.

Salmon, M., J. Wyneken, E. Fritz, and M. Lucas. 1992. Seafinding by hatchling sea turtles: role of brightness, silhouette and beach slope as orientation cues. Behaviour 122(1-2):56-77.

Schroeder, B.A., A.M. Foley, and D.A. Bagley. 2003. Nesting Patterns, Reproductive Migrations, and Adult Foraging Areas of Loggerhead Turtles. In: Loggerhead Sea Turtles. Bolten and Witherington, eds. Smithsonian Books.

SeaTurtles.Org. (n.d.). Retrieved June, 2016, from http://seaturtles.org/

Seminoff, J.A., T. Eguchi, J. Carretta, D. Prosperi, C. Allen. R. Rangel, J. Gilpatrick, K. Forney, and S.H. Peckham. 2014. Loggerhead sea turtle abundance at an offshore foraging hotspot in the eastern Pacific Ocean: implications for at-sea conservation. Endangered Species Research 24: 207–220

Seminoff, J.A., A. Resendiz, B. Resendiz, and W.J. Nichols. 2004. Occurrence of loggerhead sea turtles (*Caretta caretta*) in the Gulf of California, Mexico: evidence of life-history variation in the Pacific Ocean. Herpetological Review 35:24-27.

Seminoff, J., Steinwurtzel, M. 2014. IAC Index Nesting Beach Data Analysis (2009-2013) Final Report.

The IUCN Red List of Threatened Species. (n.d.). Retrieved June, 2016, from http://www.iucnredlist.org

Turner-Tomaszewicz, C.N., J.A. Seminoff, L. Avens, L.R. Goshe, S.H. Peckham, J.M. Rodriguez-Baron, K. Bickerman, C.M. Kurle. 2015. Age and residency duration of North Pacific loggerhead turtles (*Caretta caretta*) in an eastern Pacific Ocean. Biological Conservation 186:134-142.

Wallace, B.P., A.D. DiMatteo, B.J. Hurley, E.M. Finkbeiner, A.B. Bolten, M.Y. Chaloupka, B.J. Hutchinson, F.A. Abreu-Grobois, D. Amorocho, K.A. Bjorndal, J. Bourjea, B.W. Bowen, R. Briseño Dueñas, P. Casale, B.C. Choudhury, A. Costa, P.H. Dutton, A. Fallabrino, A. Girard, M. Girondot, M.H. Godfrey, M. Hamann, M. López-Mendilaharsu, M.A. Marcovaldi, J.A. Mortimer, J.A. Musick, R. Nel, N.J. Pilcher, J.A. Seminoff, S. Troëng, B. Witherington, and R.B. Mast. 2010. Regional Management Units for marine turtles: A novel framework for prioritizing conservation and research across multiple scales. PLoS ONE 5(12): e15465.

Vélez-Rubio GM, Estrades A, Fallabrino A y J. Tomás. 2013. Marine turtle threats in Uruguayan waters: insights from 12 years of stranding data. *Marine Biology*. 160:2797–2811.

Wallace, B.P., C.Y. Kot, A.D. DiMatteo, T. Lee, L.B. Crowder, and R.L. Lewison. 2013. Impacts of fisheries bycatch on marine turtle populations worldwide: toward conservation and research priorities. Ecosphere 4(3):40. http://dx.doi.org/10.1890/ES12-00388.1

Wallace, B.P., A.D. DiMatteo, A.B. Bolten, M.Y. Chaloupka, B.J. Hutchinson, F.A. Abreu-Grobois, J.A. Mortimer, J.A. Seminoff, D. Amorocho, K.A. Bjorndal, J. Bourjea, B.W. Bowen, R. Briseño Dueñas, P. Casale, B.C. Choudhury, A. Costa, P.H. Dutton, A. Fallabrino, E.M. Finkbeiner, A. Girard, M. Girondot, M. Hamann, B.J. Hurley, M. López-Mendilaharsu, M.A. Marcovaldi, J.A. Musick, R. Nel, N.J. Pilcher, S. Troëng, B. Witherington, R.B. Mast. 2011. Global Conservation Priorities for Marine Turtles. PloS ONE. 6(9):e24510

Witherington, B.E., K.A. Bjorndal, and C.M. McCabe. 1990. Temporal pattern of nocturnal emergence of loggerhead turtle hatchlings from natural nests. Copeia 1990(4):1165-1168.

Witherington, B.E. 1995. Observations of hatchling loggerhead turtles during the first few days of the lost year(s). Pages 154-157 *in* Richardson, J.I. and T.H. Richardson (compilers). Proceedings of the Twelfth Annual Sea Turtle Workshop on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-361.

Witherington, B.E. 2002. Ecology of neonate loggerhead turtles inhabiting lines of downwelling near a Gulf Stream front. Marine Biology 140:843-853.

Witzell, W.N. 2002. Immature Atlantic loggerhead turtles (*Caretta caretta*): suggested changes to the life history model. Herpetological Review 33(4):266-269.