Sea turtles in the Eastern Pacific region

2021 Marine Turtle Specialist Group regional report

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IUCN-SSC Marine Turtle Specialist Group

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Cover photo: Green turtle (*Chelonia mydas*; RMU CM-EP) at Colola Beach, Michoacán, México. Photo credit: Carlos Delgado-Trejo.

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Regional Overview

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Table A. Overview of Eastern Pacific country chapters submitted.

Country	Country Abbreviation used in main table (Table A)	Included in present report
Canada	CA	NO
U.S.A.	US	YES
Mexico	MX	YES
Guatemala	GT	YES
El Salvador	SV	YES
Honduras	HR	NO
Nicaragua	NI	YES
Costa Rica	CR	YES
Panama	PA	YES
Colombia	CO	YES
Ecuador	EC	YES
Peru	PE	YES
Chile	CL	YES

General remarks

Five turtle species from seven regional management units (RMUs) inhabit the waters of different countries in the East Pacific (EP) Ocean region. This Regional Overview section provides a brief summary of each RMU by species and is followed by detailed information in chapters from 11 of the countries found in the EP (Table 1).

1. RMU: Leatherback turtle (*Dermochelys coriacea*) – Eastern Pacific

1.1. Distribution, abundance, trends

1.1.1. Nesting sites

The EP leatherbacks nest at various beaches along the Pacific Coast of the Americas from Mexico to Ecuador. Within these countries there are 15 major nesting sites (e.i., >20 nests/year and >10 nests/km/year), the largest of which are located in Mexico and Costa Rica, and 149 minor nesting sites (i.e., <20 nests/year or <10 nests/km/year), the latter hosting only sporadic nesting (table 2). It is estimated that there are currently fewer than 1,000 adult female leatherbacks in the EP RMU and nesting trends are not increasing.

1.1.2. Marine areas

Satellite telemetry studies indicate that females nesting in the EP primarily migrate southward to the southern hemisphere and into the South Pacific Gyre, where they forage in pelagic waters offshore of Peru and Chile, as well as in the Central South Pacific Ocean. There is limited information on the habitat use and diving behavior of juveniles and subadults of this population. Recently have been reported pelagic foraging grounds for juveniles in Panama, Colombia, Peru, Chile and Ecuador. Ecuador's chapter mentions several interactions between artisanal fisheries and juvenile leatherbacks by pelagic longline, set nets, and drifting nets fisheries.

1.2. Other biological data

We report on the size class, trophic ecology and habitat use of leatherbacks in Peruvian waters. See table 2 for more information on biological data.

1.3. Threats

1.3.1. Nesting sites

Although the primary nesting beach are considered protected areas, egg poaching remains a concern, particularly in Costa Rica. Coastal development is also a frequent threat in the region. Climate change and its impact on beach loss and temperature regimes is a regional concern.

1.3.2. Marine areas

Unintended capture (i.e., bycatch) of adult and sub-adult leatherback turtles in fisheries operating within this species' foraging habitats are of particular concern, given the strong influence that these life stages have on population dynamics. Results from port-based surveys administered along the coast of South America indicate that between 1000 and 2000 EP leatherback turtles are caught in regional small-scale fisheries annually, and approximately 30% - 50% of the captures result in turtle mortality.

1.4. Conservation

Sea turtles are protected under national law in all the countries included in this report. These countries have signed several regional and international marine –and sea turtle– protection agreements, such as The Inter-American Convention for the Protection and Conservation of Sea Turtles, Convention on Biological Diversity, and Convention on International Trade in Endangered Species of Wild Fauna and Flora.

In March 2012, an Expert Working Group was assembled to develop a Regional Action Plan and support efforts to halt and reverse the decline of the EP leatherback turtle. The Regional Action Plan emphasizes the importance of protecting all nests in the region, identifying and mitigating areas of high bycatch risk, and the need to expand port-based marine turtle bycatch assessments. Moreover, The Regional Action Plan acknowledges that mortality due to fisheries bycatch represents the primary impediment to EP leatherback turtle recovery and asserts that a better understanding of post-interaction mortality rates is crucial for a sound assessment of the true impact of fisheries bycatch on this species.

One of the most important outcomes of the Expert Working Group was the conformation of Laúd OPO, which is a Conservation Network designed to support research and recovery of this critically endangered sea turtle population at local and regional scales.

1.5. Research

Table 2 summarizes the scientific studies conducted on leatherbacks in the region.

2. RMU: Leatherback turtle (*Dermochelys coriacea*) West Pacific

2.1. Distribution, abundance, trends

2.1.1. Nesting sites

West Pacific leatherbacks nest exclusively in the Indo-Pacific (primarily in Indonesia, Papua New Guinea and the Solomon Islands). There are indications of a long-term decline in the nesting population.

2.1.2. Marine areas

Satellite telemetry has shown that many WP leatherbacks migrate across the Pacific Ocean and forage in areas off the Pacific Coast of the USA.

2.2. Other biological data

Table 2.

2.3. Threats

2.3.1. Nesting sites

The consumption of leatherback meat and eggs is a problem at nesting sites in much of the WP.

2.3.2. Marine areas

Unintended capture and mortality of adult and sub-adult leatherback turtles in industrial longline and drift gillnet fisheries operating off the coast of California and Oregon represent important threats to the population.

2.4. Conservation

The Pacific Leatherback Conservation Area (PLCA) is a management zone spanning the California/Oregon Coast that was established in 2001 and closes to the fishery annually from August 15 to November 15 to limit bycatch.

2.5. Research

Table 2.

3. RMU: Hawksbill turtle (*Eretmochelys imbricata*) – Eastern Pacific

3.1. Distribution, abundance, trends

3.1.1. Nesting sites

Six major hawksbill nesting sites and 40 minor nesting sites have been identified in Mexico, El Salvador, Nicaragua, Panama and Ecuador (Table 2). The largest rookeries identified to date are located within mangrove estuaries in El Salvador and Nicaragua.

3.1.2. Marine areas

Spatial ecology studies indicate juvenile and adult hawksbills primarily inhabit neritic foraging areas which is confirmed by reports from Mexico, El Salvador, Nicaragua, Costa Rica, Panama, Colombia, Ecuador. Post-nesting female hawksbills in El Salvador, Nicaragua and Ecuador have been documented primarily inhabiting mangrove estuaries. Spatial ecology suggest that post-nesting females undergo limited migrations or are non-migratory, while genetic research suggests post-hatchlings remain in the general vicinity of their nesting beaches, the latter referred to as natal foraging philotpatry.

Although hawksbills can be found at marine areas with hard bottom substrates throughout the region, foraging grounds of particular importance include Isla San Jose and Isla Espiritu Santo in Mexico; Los Cobanos, Jiquilisco Bay and Punta Amapala in El Salvador; Gulf of Fonseca in Honduras; Estero Padre Ramos and Aserradores in Nicaragua; Gulf of Nicoya and Sweet Gulf in Costa Rica; Coiba Island in Panama; Isla Gorgona in Colombia; Jambeli Archipelago in Ecuador; and the Tumbes sanctuary in Peru.

3.2. Other biological data

Table 2.

3.3. Threats

3.3.1. Nesting sites

The collection of hawksbill eggs –and to a lesser extent meat– for consumption, the intentional capture of hawksbills from nesting beaches for the harvesting and sale of their carapaces, and coastal development, all represent frequent and ongoing threats in the region, particularly in Central America. Beach loss and flooding due to climate change is a regional concern.

3.3.2. Marine areas

Mortality caused by blast fishing (i.e., fishing with homemade explosives) in mangrove estuaries and bottom-set gillnets on nearshore rocky reefs represent major threats to all life stages of hawksbill turtles, particularly in El Salvador and Nicaragua. The opportunistic capture of hawksbill for the harvesting and sale of their carapaces is also commonplace. The impacts of climate change on mangrove ecosystems and hard bottom substrates, such as coral reefs, which has the potential to reduce the carrying capacity of these habitats for hawksbills, is of regional concern.

3.4. Conservation

Sea turtles are protected under national law in all the countries included in this report, and these countries have signed several regional and international marine –and sea turtle– protection agreements.

The USFWS Strategic Plan developed to address the critically endangered status of hawksbill turtle in the EP highlights the importance of cooperation with international partners to identify regions of concern for fisheries interactions in waters off Central and South America. Furthermore, this plan prioritizes capacity building and training in fishing communities to promote best practices for avoiding interactions when feasible and for safely handling and releasing captured turtles.

One of the most important regional developments in support of EP hawksbills was the conformation of Eastern Pacific Hawksbill Network (ICAPO) in 2008, which is a group of individuals and organizations that collaboratively works to promote and support the research and recovery of EP hawksbills at local and regional scales.

3.5. Research

Table 2. summarizes the scientific studies conducted on hawksbills in the region.

4. RMU: Green turtle (*Chelonia mydas*) Eastern Pacific

4.1. Distribution, abundance, trends

4.1.1.Nesting sites

Green turtles nest along the coast of the Americas from Mexico to Peru. Here we present nesting data from 39 mayor nesting sites at Mexico, Nicaragua, Costa Rica, Panama, and Ecuador, and 29 minor nesting sites at Nicaragua, Costa Rica, Colombia and Ecuador (Table 2).

4.1.2.Marine areas

Juvenile green turtles use neritic habitats and coastal lagoons along most of the Pacific coastline of the Americas for feeding and development grounds. Other biological data Table 2.

4.2. Threats

4.2.1.Nesting site

Egg poaching, female (i.e., meat) consumption and coastal development represent frequent threats in the region. Climate change and its impact on beach loss and temperature regimes is a regional concern.

4.2.2.Marine areas

Unintended capture (i.e., bycatch) of EP green turtles by nearshore fisheries, particularly gillnets, are of particular concern. Pollutants and boat strikes have been identified as major threats on the foraging grounds at the coastal areas of the U.S.A.

4.3. Conservation

Sea turtles are protected under national law in all the countries included in this report/ These countries have signed several regional and international marine –and sea turtle– protection agreements.

One the most important nesting sites for the population is located in Michoacán, Mexico, and long-term monitoring has been used to model multidecadal population trends, which indicate the number of nesting females has increased dramatically since 2000.

Since boat strikes were identified as a threat to green turtles in the U.S.A., boats are required to reduce their speed within the bay to mitigate the threat.

4.4. Research

Table 1. summarizes the scientific studies conducted on green turtles in the region.

5. RMU: Olive ridley (*Lepidochelys olivacea*) – Eastern Pacific

5.1. Distribution, abundance, trends

5.1.1.Nesting sites

The olive ridley is the most abundant sea turtle in EP, where the species shows two nesting strategies in the region. It is usually a solitary nesting species but at select beaches in Mexico, Costa Rica, Nicaragua, and Panama the species also partakes in mass synchronous nesting events termed "arribadas" (Table 1).

5.1.2.Marine areas

This species is mostly pelagic, but it is has also been reported at neritic foraging grounds in four countries (Mexico, El Salvador, Panama, Peru and Chile).

5.2. Other biological data

Table 2.

5.3. Threats

5.3.1.Nesting sites

Egg poaching, female (i.e., meat) consumption and the loss/modification of nesting habitat to coastal development are frequent threats in the region. Climate change and its impact on beach loss is a regional concern.

5.3.2.Marine areas

Unintended capture of adult and sub-adult of olive ridleys by fisheries operating within this species' foraging habitats are of particular concern, given the strong influence that these life stages have on population dynamics.

5.4. Conservation

Sea turtles are protected under national law in all the countries included in this report, also, these countries have signed several regional and international marine –and sea turtle– protection agreements.

5.5. Research

Table 2. summarizes the scientific studies conducted on olive ridleys in the region.

6. RMU: Loggerhead turtle (*Caretta caretta*) – North Pacific

6.1. Distribution, abundance, trends

6.1.1.Nesting sites

N/A

6.1.2.Marine areas

The nearshore waters of the Gulf of Ulloa, Mexico, represent one the most important aggregation areas for juveniles of the NP loggerhead population. Juveniles are also reported as being itermittently present in the Southern California Bight, U.S.A., in association with El Niño Southern Oscillation events. The NP loggerhead population nests exclusively in Japan.

6.2. Other biological data

Table 2.

6.3. Threats

6.3.1.Nesting sites

N/A

6.3.2.Marine areas

Unintended capture of juveniles and sub-adult of loggerhead by fisheries operating within this species' foraging habitats are of particular concern, given the strong influence that these life stages have on population dynamics.

6.4. Conservation

Sea turtles are protected under national law in all the countries included in this report, also. These countries have signed several regional and international marine –and sea turtle– protection agreements.

6.5. Research

Table 2. summarizes the scientific studies conducted on loggerheads in the region.

7. RMU: Loggerhead turtle (*Caretta caretta*) – South Pacific

7.1. Distribution, abundance, trends

7.1.1.Nesting sites

N/A

7.1.2.Marine areas

The nearshore waters of Peru and Chile are among the most important aggregation areas of juveniles of the SP loggerhead population, with individuals originating from nesting beaches in Australia and New Caledonia.

7.2. Other biological data

N/A

7.3. Threats

7.3.1. Nesting sites

N/A

7.3.2. Marine areas

Unintended capture of juveniles and sub-adult of loggerhead by fisheries operating within this species' foraging habitats are of particular concern, given the strong influence that these life stages have on population dynamics.

7.4. Conservation

Sea turtles are protected under national law in all the countries included in this report, also, these countries have signed several regional and international marine –and sea turtle– protection agreements.

7.5. Research

N/A

Table 1. Key biological information for sea turtles RMUs in the Eastern Pacific Ocean. Country chapters: US-United States, MX-Mexico, GT-Guatemala, SV-El Salvador, NI-Nicaragua, CR-Costa Rica, PA-Panamá, CO-Colombia, EC-Ecuador, PE-Perú, CL-Chile.

	Caretta caretta		***Chelonia mydas***		***Dermochelys coriacea***		***Eretmochelys imbricata***		***Lepidochelys olivacea***	
RMU	**CC - EP**	**Country chapters**	**CM - EP**	**Country chapters**	**DC - EP**	**Country chapters**	**EI - EP**	**Country chapters**	**LO - EP**	**Country chapters**
Occurrence										
Nesting sites			Y	PE,CO,CR, SV, NI, MX, EC, PA	Y	CO,CR, SV, NI, MX, EC, GT	Y	SV, NI, MX, EC, PA	Y	PE,CO,CR, SV, N, MXI, EC, PA, GT
Pelagic foraging grounds	Y	PE, CL, EC, US	Y, JA	PE, CL,CO, SV, MX, EC, US, PA	Y	PE, CL,CO, EC, US,PA	Y, J	CO, MX, EC,PA	Y, JA, A	PE, CL,CO, SV, MX, PA
Benthic foraging grounds	Y,J	US	Y,JA	PE, CL,CO,CR, SV, MX, EC, PA	Y	PE, US	Y,JA, J	PE, CL,CO,CR, SV, NI, MX, EC,PA	Y, JA, A	PE, CL, SV, MX,PA, GT
Key biological data										
Nests/yr: recent average (range of years)	38.3 (2010 - 2014)	EC	3132.3 (2007 - 2018)	PE, CO, CR, NI, MX, EC	7.1 (2004 - 2020)	CR, NI, EC, GT	17 (2008 -2018)	CR, NI, MX, EC	21399 (1998 - 2019)	PE,CO, CR, NI, MX, EC,GT
Nests/yr: recent order of magnitude			1_2769	PE, EC			1_46	EC	1 - 1390985	PE, CR, EC
Number of "major" sites (>20 nests/yr AND >10 nests/km yr)			39	CR,NI, MX, EC, PA	15	CR,NI, MX	6	NI, MX, EC	98	CO, CR, NI, MX, EC, PA
Number of "minor" sites (<20 nests/yr OR <10 nests/km yr)			29	CO, CR, NI, EC	145	CO, CR, NI, MX, EC	23	CR, NI, MX, EC	61	PE, CO, CR, NI, EC
Nests/yr at "major" sites: recent average (range of years)	38.3 (2010 - 2014)	EC	6249 (2008 - 2015)	NI,MX, EC	23.6 (2010 - 2016)	NI	35 (2007 - 2017)	NI, MX, EC	19707 (1991 - 2017)	CO, NI, MX, EC
Nests/yr at "minor" sites: recent average (range of years)			9.3 (2007 - 2017)	CO, CR, NI, EC	8.3 (2004 - 2018)	CO;CR, NI, EC	3 (2008 - 2018)	CR, NI, MX, EC	15 (2008 - 2018)	PE,CO; CR, NI, EC
Total length of nesting sites (km)			641.45	CR, SV, NI, MX, EC, PA	429.3	CR, SV, NI, MX, EC, GT	197.7	CR, SV, NI, MX, EC	1109.83	PE, CR, SV, NI, MX, EC, PA,GT
Nesting females / yr			6130.7	CR, MX, EC	34.8	CR, GT	47.4	SV, EC	586924	CR
Nests / female season (N)			4.3 (4769)	CR, EC	4.11(>110)	CR / PA	2.2 (255) /5	SV, EC	3.85 (1929)	CR
Female remigration interval			3.4 (947)	CR, MX, EC	3.1	CR, MX	2.5 (73)	SV, MX,	1.5	MX

(yrs) (N)								EC,PA		
Sex ratio: Hatchlings (F / Tot) (N)					0.85	CR	0.69 - 0.85 (705 clutches)	SV		
Sex ratio: Immatures (F / Tot) (N)			35/45 (n=45)	US			0.86 (77)	SV	0.57	
Sex ratio: Adults (F / Tot) (N)							0.46 (57)	CR, SV, EC		
Min adult size, CCL or SCL (cm)			76.6	CR, NI, MX, EC	138	CR, NI, MX	58; 66.6;69.95; 93; 67	SV, NI, CR, MX, EC	62.5	PE,CO,CR, NI, MX
Age at maturity (yrs)	25 -30	MX	20 - 30	CR, MX	13-14	MX			10-18 años	MX
Clutch size (n eggs) (N) número de nidos			75 (3979)	SV, NI, MX, EC,PA	63 (719)	CR, SV, NI, MX	196 (1118)	SV, NI, MX, EC,PA	98 (213)	CO, SV, NI, MX,PA
Emergence success (hatchlings/egg) (N) N:nidos			0.7 (2553)	CR, SV, N, MX,PA	0.38 (1018)	CR, SV; NI; MX	0.65 (1862)	SV, NI, MX, EC	0.6 (20807)	CO, CR, NI,PA
Nesting success (Nests/ Tot emergence tracks) (N)			0.6 (22023)	CR, EC	0.9	CR	0.62 (184)	EC	99%	PA
Trends										
Recent trends (last 20 yrs) at nesting sites (range of years)					Declining (90%) (1988 - 2018)	CR, NI			STABLE	CO; CR; NI
Recent trends (last 20 yrs) at foraging grounds (range of years)	43226 (2015)	MX	Decreasing (2002-2010)	US						
Oldest documented abundance: nests/yr (range of years)			76 (2012)	SV	32 (2014 - 2015)	CR, SV	164 (1996 - 2015)	SV, EC	11137.5 (1998 - 2010)	CO,CR, SV,PA
Published studies										
Growth rates	Y	MX	Y	PE, CL,CO, MX,EC, US	Y	CR	Y	EC,PA		
Genetics	Y	PE, US	Y	PE, CL,CO,CR,EC, US	Y	PE, CL, CR	Y	PE,CO, CR, SV, NI,EC,PA	Y	PE,CO, MX
Stocks defined by genetic markers	Y	MX, US	Y	CL,CO, CR,EC, US	Y	CL, CR	Y	CO, CR, SV, NI,EC,PA	Y	PE,CO
Remote tracking (satellite or other)	Y	PE,MX,US	Y	CL,CO, CR,NI, MX, EC,US	Y	PE, CR, MX	Y	PE,CO, SV, NI, MX, EC,PA	Y	MX
Survival rates			Y	MX,US	Y	CR, MX			Y	MX
Population dynamics	Y	CL,US,MX	Y	PE, CL,CO, EC,US	Y	CL, CR	Y	NI, MX, EC	Y	CO, MX
Foraging ecology (diet or isotopes)	Y	PE, CL, MX,US	Y	PE, CL,CO, CR, SV, MX,US	Y	PE, CL, CR	Y	CR, SV, NI, EC	Y	PE, MX
Capture-Mark-Recapture	Y	MX	Y	PE, CL,CO, CR, SV, MX, EC,US	Y	CR	Y	CO, CR, SV, NI, EC,PA	Y	CO, CR, MX

Threats										
Bycatch: presence of small scale / artisanal fisheries?	Y (PLL, DN, DLL)	PE, MX,US	Y(PLL, SN,DLL, DN,OTH, PT, FP, PN)	PE,CO, CR, NI, MX,US,PA	Y(PLL,SN,DN, FP)	PE,CO, NI, MX, EC	Y (SN, PLL,OTH, PN, DLL, DN, ST, MT)	PE,CO, CR, SV, NI, EC,PA	Y (PLL, SN, DN, PT,ST, DLL, MT)	CO, CR, SV, NI, MX, EC,PA
Bycatch: presence of industrial fisheries?	Y (PLL, SN, BT)	EC,US	Y (PLL, SN, BT, ST, DLL, PN, DN, MT, PT)	CO, CR, SV, MX, EC,US,PA	Y (PLL, PT, PN, SN, FP, BT)	PE,CO, MX, EC	Y (PLL, SN, BT, PT, MT, FP, ST)	CO, CR, MX,PA	Y (PLL, ST, BT,SN)	CO,CR,SV,EC,PA
Bycatch: quantified?	Y (PLL)	PE, MX,US	Y PLL,DLL	CO,US,PA	Y(PLL,SN,DN)	PE,CO	Y SN,	CO, SV, NI,PA	Y (PLL, SN, DN, PT,DLL)	CO,PA
Take. Intentional killing or exploitation of turtles	Y	MX	Y	PE,CO, MX,PA	Y	PE,CO, MX,PA	Y	PE,CO, SV, MX, EC,PA	Y	PE,CO, NI, MX, EC,PA
Take. Egg poaching			Y	CO, CR, SV, NI, MX,PA	Y	CO,CR, SV, NI, MX,PA	Y	CO, CR, SV, NI, EC,PA	Y	PE,CO, CR, SV, NI, MX, EC,PA
Coastal Development. Nesting habitat degradation			Y	CO, CR, SV, MX, EC,PA	Y	CO, CR, SV, NI, EC,PA	Y	CO, CR, SV, MX, EC,PA	Y	PE,CO, CR, SV, NI, MX, EC,PA
Coastal Development. Photopollution			Y	CO, CR, SV, MX, EC	Y	CO, CR, SV, EC	Y	CO, CR, SV, MX, EC	Y	PE,CO,CR,SV, MX, EC
Coastal Development. Boat strikes	Y	MX	Y	PE,CO, CR, SV, MX, EC,US,PA	Y	CO, CR,PA	Y	CO, CR, SV, MX, EC,PA	Y	CO, CR, MX, EC,PA
Egg predation			Y	CO, CR, MX, EC,PA	Y	CO, CR,PA	Y	CO, CR, SV,EC,PA	Y	CO, CR, NI, MX, EC,PA
Pollution (debris, chemical)	Y	PE, MX	Y	PE,CO, CR, MX,EC,US,PA	Y	CO, CR, MX,PA	Y	CO, CR, SV, MX, EC,PA	Y	CO, CR, MX, EC,PA
Pathogens	Y	MX	Y	PE, CR, EC			Y	CR	Y	CR
Climate change	Y	US	Y	PE, CR, MX,US,PA	Y	PE, CR,PA	Y	CR, MX, EC,PA	Y	CR, MX, EC,PA
Foraging habitat degradation			Y	PE,CO, CR, SV, MX, EC,US,PA	Y	CO,PA	Y	CO, CR, SV, MX, EC,PA	Y	CO, CR,PA
Other (Parasites/Simbionts)			Y	PE, SV, EC			Y	MX, EC	Y	SV, EC
Long-term projects										
Monitoring at nesting sites			Y	PE,CO, CR, SV, NI, MX, EC,PA	Y	CR, SV, NI, MX, EC	Y	CO, CR, SV, NI, MX, EC	Y	PE,CO,CR, SV, NI, MX, EC,PA
Number of index nesting sites			33	CR, SV, NI, MX, EC	24	CR, SV, NI, MX	15	SV, NI, EC,PA	57	CO, CR, SV, NI. MX, EC
Monitoring at foraging sites	Y	MX,US	Y	CR, SV, MX, EC,US	Y	EC	Y	CR, SV, NI, EC		
Conservation										
Protection under national law	Y	PE, MX, EC,US	Y	PE,CO, CR, SV,NI, MX, EC,US,PA	Y	PE,CO, CR, SV, NI, MX, EC,PA	Y	PE,CO, CR, SV, NI, MX, EC,PA	Y	PE,CO, CR, SV, NI, MX, EC,PA

Number of protected nesting sites (habitat preservation)			58	CO, CR, SV, NI,EC,PA	16	CO, CR, SV, NI	23	CO, CR, SV, NI, EC	58	CO, CR, SV, NI, EC,PA
Number of Marine Areas with mitigation of threats	1	MX	43	PE,CO, CR,EC,EU,PA	29	PE,CO,CR	38	PE,CO, CR, SV,NI, EC,PA	43	PE,CO, CR, EC,PA
Long-term conservation projects (number)	8	MX,PE	47	PE,CO, CR,SV, NI,EC,US,PA	16	PE, CR, SV, NI, EC	18	PE,CO, CR, SV, NI, EC,PA	64	PE,CO, CR, SV, NI, EC,PA
In-situ nest protection (eg cages)			Y	CO, CR, NI,EC,PA	Y	CR, EC	Y	CR, SV, NI, MX, EC,PA	Y	CO,CR, SV, NI, MX, EC,PA
Hatcheries			Y	CO, CR, SV, NI, MX, EC,PA	Y	CR, SV, NI, MX	Y	SV, NI, MX, EC,PA	Y	CO, CR, SV, NI, MX, EC,PA
Head-starting										
By-catch: fishing gear modifications (eg, TED, circle hooks)	Y	MX, EC	Y	PE,CO, CR, SV, NI, MX, EC,PA	Y	PE,CO, NI, MX, EC,PA	Y	PE,CO, CR, SV, NI, MX, EC,PA	Y	PE,CO, SV, NI, MX, EC,PA
By-catch: onboard best practices	Y	PE, MX, EC	Y	PE,CO, CR, MX,PA	Y	PE,CO, EC,PA	Y	PE,CO, CR, SV, NI, MX,PA	Y	PE,CO, NI,PA
By-catch: spatio-temporal closures/reduction	Y	MX,US	Y	CO, SV, NI, MX	Y	CO, NI, MX	Y	CO, SV, NI, MX	Y	CO, SV, NI, MX
Hibridization			Y	PE			Y	PE		
Health			Y	PE						

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1. RMU: Loggerhead turtle (*Caretta caretta*) – North Pacific

Although rare, juvenile loggerhead turtles from the North Pacific Regional Management Unit (RMU) have been documented sporadically in U.S. waters at the extreme northern extent of their range.

1.1. Distribution, abundance, trends

1.1.1. Nesting sites

Not applicable.

1.1.2. Marine areas

Juvenile loggerhead (Caretta caretta) turtles have been documented sporadically in the Southern California Bight (SCB) by fishermen and aerial surveys (2, 13, 25). Remote tracking combined with genetic and diet analyses have shown that the turtles found in the SCB belong to the North Pacific Regional Management Unit (RMU), which nest in Japan and most commonly forages off of the coast of Mexico (1, 2, 3, 6, 11, 25). *Caretta caretta* sightings have not been registered each year, and their intermittent presence off of the California coast seems to be most closely linked to the warmer waters associated with El Niño Southern Oscillation (ENSO) events (14, 25, 27). See Figure 1 for loggerhead observations within the SCB.

1.2. Other biological data

Not applicable.

1.3. Threats

Bycatch, reported by fisher observers, is the greatest threat posed to loggerhead sea turtles in the pacific U.S.A. There is documentation that loggerhead turtles interact with both California's Drift Gillnet Fishery (CDGN) and pelagic longline fisheries in Pacific U.S.A. waters, and that these interactions have often been lethal (14, 27, 30, 37, 52).

1.4. Conservation

Loggerhead turtles are protected under the U.S. Endangered Species Act (ESA), which makes it illegal to kill, import, export, or sell them in interstate commerce. The overlap of loggerhead turtle range and the California Drift Gillnet Fishery within the SCB prompted policy makers to designate an area off southern California (see Fig. 1) that closes to the drift gillnet fishery during ENSO events (15, 27, 44). This spatio/temporal closure has resulted in a decreased number of loggerhead fishery interactions in the SCB since the creation of the conservation area (15). Conservation efforts are currently focused on developing strategies for identifying ENSO events earlier so as to close the conservation area before any turtles enter the SCB (14).

1.5. Research

Published research is summarized in Table 1. Current and future research is focusing on better predicting when loggerhead turtles may be present in the SCB in order to close the protected area to fisheries more efficiently and reduce fishery-turtle interactions (14).

2. RMU: Green turtle (*Chelonia mydas*) – East Pacific

Green turtles from the East Pacific RMU utilize various foraging sites in coastal U.S. waters.

2.1. Distribution, abundance, trends

2.1.1. Nesting sites

Not applicable.

2.1.2. Marine areas

Resident green turtle (*Chelonia mydas*) populations have been well documented in two sites off of California: The San Diego Bay (SDB) in San Diego and the San Gabriel River (SGR) within the Seal Beach (SB) National Wildlife Refuge in Los Angeles (see Fig. 2). These foraging areas in California originally became uniquely habitable for green turtles year-round due to warmer water caused by power plant emissions (19, 20, 23, 24, 42, 43, 51). The plants, when open, used sea water to cool off the machinery and returned the warmer water back to the ocean, thus creating ideal habitat for green turtles (19, 20, 24, 42, 43, 51). The plants have now been decommissioned, and the surrounding waters are cooling and it is still not clear how this will affect the green turtle foraging habitat.

Genetic analysis and satellite tracking studies have determined that the green turtles that forage in the San Diego Bay belong to the East pacific RMU, and nest primarily in the Revillagigedo Archipelago and along the coast of Michoacán, Mexico (22, 40).

A recent study found that since 2015 a new resident population of 6 green turtles has established off of La Jolla Shores (LJS), San Diego (32). Although these waters reach the lowest ambient temperature recorded for green turtles, the individuals seem to have acclimated to the consistently colder temperatures (32)

2.2. Other biological data

Not applicable.

2.3. Threats

Because the SDB and SGR green turtle populations aggregate off of highly developed coastal areas, pollutants and contamination have been identified as a major threat to their survival (6, 7, 38, 39, 42). Studies specifically found elevated levels of bioaccumulated trace metals such as Ag, Cd, Cu, Mn, Se, and Zn in the food web and in the foraging grounds (7, 38, 39). Elevated quantities of polychlorinated biophenyls (PCBs), which are associated with neurotoxicity, were also found in green turtles foraging in the SDB (6).

Because both of these foraging sites are located close to recreation areas, boat strikes have also proven to be a threat to green turtles in San Diego and Los Angeles (24, 42, 43).

In addition, these two areas became habitable to green turtles only because of the warm waters created by power plant activities, and now that the plants are closed, the habitats may become unsuitable for green turtles (9, 24, 42, 43, 51). While the turtles continue to utilize the areas, studies show that they have begun to disperse more and it remains unclear if the populations will remain in the SDB and SGR as the water cools to its natural temperature (9, 24, 42, 43, 51).

2.4. Conservation

Green turtles are protected under the U.S. Endangered Species Act (ESA), which makes it illegal to kill, import, export, or sell them in interstate commerce. These populations are being monitored to better understand how they will be affected by the closure of the power plants (19, 20, 24). Long-term mark-recapture in the SDB report that capture rates have decreased, but hypothesize that this reduction is due to turtles using more dispersed foraging sites (51).

Since boat strikes were identified as a threat to the SDB green turtles, boats are required to reduce their speed within the bay to mitigate the threat (42, 43).

2.5. Research

Published research is summarized in Table 1. Current and future research is focused on monitoring the site-use behavior of these populations to determine how they respond to the closure of the power plants (19, 24, 42, 50).

3. RMU: Leatherback turtle (*Dermochelys coriacea*) – West Pacific

U.S. coastal waters provide valuable foraging habitat for leatherback turtles from the West Pacific RMU.

3.1. Distribution, abundance, trends

3.1.1. Nesting sites

Not applicable.

3.1.2. Marine areas

Leatherback turtles forage along the Pacific coast of the U.S. (see Fig. 4), with a range spanning from California to Oregon (5, 8, 10, 12, 31, 45). Genetic and satellite telemetry studies have determined that these leatherbacks are part of the west pacific RMU and complete a transatlantic migration from their nesting beaches in Indonesia (5, 8, 9, 41, 45).

3.2. Other biological data

Not applicable.

3.3. Threats

Recent evaluation has determined that the western Pacific leatherback population has declined by 5.6% in the past 1990 (14). One of the greatest threats to this population of leatherback turtles is fisheries bycatch, specifically from the California/Oregon Drift Gillnet Fishery (CDGN) and the California-based pelagic longline fishery (16, 17, 18, 19, 21, 24, 37, 41, 47, 49, 52).

Other threats include coastal development, which has led to more waste and vessel transit in leatherback foraging habitat off of California (14), the ingestion of oil, present in California waters due to increased oil extraction activities (14), and climate change, which is causing shifts in leatherback phenology and changes to upwelling patterns necessary for leatherback food sources (14).

3.4. Conservation

Leatherback turtles are protected under the U.S. Federal Endangered Species Act (ESA), which makes it illegal to kill, import, export, or sell them in interstate commerce. Established in 2001 to limit the bycatch of leatherbacks by the CDGN, the Pacific Leatherback Conservation Area (PLCA) is a zone spanning the California/Oregon Coast that closes to the fishery annually from August 15 to November 15 (15, 17, 18, 21, 44). Since this conservation area was implemented, the incidental capture of leatherbacks has decreased (16, 17, 18, 37). See Figure 3 for a map of the PLCA.

The Center for Biological Diversity and Turtle Island Restoration Network presented a petition to the California Department of Fish and Wildlife in 2020 to list leatherbacks as endangered in the California Endangered Species Act, which would increase protection and monitoring of the leatherbacks present along the coast of California (14).

3.5. Research

Research to date is summarized in Table 1.

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Table 1. Biological and conservation information about sea turtle Regional Management Units in the U.S.A.

RMU:	C. caretta (North Pacific)	ref #	C. mydas (East Pacific)	ref #	D. coriacea (West Pacific)	ref #
Occurrence						
Nesting sites	N		N		N	
Oceanic foraging areas	Y (J)	2, 13, 25	Y (J,A)	28, 43	Y (A)	5, 45
Neritic foraging areas	Y (J)	2, 13, 25	Y (A)	32	Y (A)	5, 45
Key biological data						
Nests/yr: recent average (range of years)	n/a		n/a		n/a	
Nests/yr: recent order of magnitude	n/a		n/a		n/a	
Number of "major" sites (>20 nests/yr AND >10 nests/km yr)	n/a		n/a		n/a	
Number of "minor" sites (>20 nests/yr OR >10 nests/km yr)	n/a		n/a		n/a	
Nests/yr at "major" sites: recent average (range of years)	n/a		n/a		n/a	
Nests/yr at "minor" sites: recent average (range of years)	n/a		n/a		n/a	
Total length of nesting sites (km)	n/a		n/a		n/a	
Nesting females / yr	n/a		n/a		n/a	
Nests / female season (N)	n/a		n/a		n/a	
Female remigration interval (yrs) (N)	n/a		n/a		n/a	
Sex ratio: Hatchlings (F / Tot) (N)	n/a		n/a		n/a	
Sex ratio: Immatures (F / Tot) (N)	n/a		35/45 (n=45)	2	n/a	
Sex ratio: Adults (F / Tot) (N)	n/a		51/69 (n=69)	2	n/a	

Min adult size, CCL or SCL (cm)	n/a		n/a		144 ccl	33
Age at maturity (yrs)	n/a		n/a		n/a	
Clutch size (n eggs) (N)	n/a		n/a		n/a	
Emergence success (hatchlings/egg) (N)	n/a		n/a		n/a	
Nesting success (Nests/ Tot emergence tracks) (N)	n/a		n/a		n/a	
Trends						
Recent trends (last 20 yrs) at nesting sites (range of years)	n/a		n/a		n/a	
Recent trends (last 20 yrs) at foraging grounds (range of years)	n/a		Decreasing (2002-2010) (see text)	51	Down 5.6% since 1990	14
Oldest documented abundance: nests/yr (range of years)	n/a		n/a		n/a	
Published studies						
Growth rates	N		Y	29	N	
Genetics	Y	11	Y	22	Y	41
Stocks defined by genetic markers	Y	11	Y	22	Y	41
Remote tracking (satellite or other)	Y	25, 27	Y	19, 29, 42, 43	Y	5, 8
Survival rates	N		Y	28	N	
Population dynamics	Y	27	Y	3, 22, 28	Y	
Foraging ecology (diet or isotopes)	Y	2	Y	3, 4, 48	Y	34
Capture-Mark-Recapture	N		Y	28, 29	N	
Threats	Bycatch (DN)		Pollution/Contaminants, Boat Strikes		Bycatch (DN, PLL)	

Bycatch: presence of small scale / artisanal fisheries?	n/a		n/a		n/a	
Bycatch: presence of industrial fisheries?	DN, PLL	14, 27, 36, 41, 46, 52	PLL	41	DN, PLL	16, 17, 18, 19, 24, 36, 37, 41, 47, 49, 52
Bycatch: quantified?	Y	14, 27, 30, 37, 52	n/a		Y	16, 17, 18, 37
Intentional killing of turtles	N		N		N	
Take. Illegal take of turtles	N		N		N	
Take. Permitted/legal take of turtles	N		N		N	
Take. Illegal take of eggs	N		N		N	
Take. Permitted/legal take of eggs	N		N		N	
Coastal Development. Nesting habitat degradation	N		N		N	
Coastal Development. Photopollution	N		n/a		N	
Coastal Development. Boat strikes	n/a		Y	24, 42, 43	Y	14
Egg predation	N		N		N	
Pollution (debris, chemical)	n/a		Y	6, 7, 38, 39, 42	Y	14, 33
Pathogens	n/a		n/a		n/a	
Climate change	Y	14	Y	42	Y	5, 14
Foraging habitat degradation	n/a		Y	9, 24, 42, 43, 51	Y	14
Other						
Long-term projects (>5yrs)						
Monitoring at nesting sites (period: range of years)	n/a		n/a		n/a	
Number of index nesting sites	n/a		n/a		n/a	
Monitoring at foraging sites (period: range of years)	Y		Y		Y	
Conservation						
Protection under national law	Y	42	Y	42	Y	42
Number of protected nesting sites (habitat	n/a		n/a		n/a	

preservation) (% nests)						
Number of Marine Areas with mitigation of threats	1	25	1	42, 43	1	15, 17, 18
N of long-term conservation projects (period: range of years)			1	NOAA	Y	
In-situ nest protection (eg cages)	n/a		n/a		n/a	
Hatcheries	n/a		n/a		n/a	
Head-starting	n/a		n/a		n/a	
By-catch: fishing gear modifications (eg, TED, circle hooks)						
By-catch: onboard best practices						
By-catch: spatio-temporal closures/reduction	Y	13, 25, 41	N		Y	15, 17, 18, 44
Other						

Table 2. International conventions protecting sea turtles and signed by the U.S.A.

International Conventions	Signed	Binding	Compliance measured and reported	Species	Conservation actions	Relevance to sea turtles
The Inter-American Convention (IAC) for the Protection and Conservation of Sea Turtles	Y	Y	Y	CC, CM, EI, DC, LO, LK	Prohibition of intentional capture, retention or killing of, and domestic trade in sea turtle products; compliance with CITES obligations; restriction of human activities that could negatively impact sea turtles; protection, restoration and conservation of sea turtle populations and their habitats; promotion of scientific research relating to turtles and their habitats; promotion of education and outreach about sea turtles; reduction of incidental capture of sea turtles during fishing practices	Aims to protect, restore, conserve, and research sea turtle populations and their habitats throughout the Americas
Convention on International Trade in Endangered Species of Wild Fauna and Flora	Y	Y	Y	ALL	Prohibits the international trade of endangered species and their products, including sea turtles	Under CITEs, sea turtle meat, eggs, and carapaces cannot be traded internationally
Convention on Wetlands of International Importance	Y	Y	Y	ALL	Unites efforts to conserve wetlands and limit the use of the important habitats	Wetlands protected under the convention provide important habitats for sea turtles
Convention on Biological Diversity	Y	Y	Y	ALL	Promotes the conservation of biological diversity, the sustainable use of the components of biological diversity, and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources	Protects habitats important to sea turtle populations

Convention on Fishing and Conservation of the Living Resources of the High Seas	Y	Y	Y	ALL	Creates international cooperation around the problems involved in the conservation of living resources of the high seas, considering that because of the development of modern technology some of these resources are in danger of being overexploited	Limits the extraction of limited oceanic resources, thus protecting sea turtles' habitats and food sources
United Nations Convention on the Law of the Sea	Y	Y	Y	ALL	Parties agree to cooperate in resolving issues related to the law of the sea	Protects habitats important for sea turtle lifecycles that fall outside of any governmental jurisdiction
The International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL)	Y	Y	Y	ALL	Regulates, prevents and minimizes pollution from ships - both accidental pollution and that from routine operations, and places controls on operational discharges are included in most Annexes.	Helps mitigate threats that turtles face from contaminants related to ships, such as oil
Convention on Nature Protection in the Western Hemisphere	Y	Y	Y	CC, CM, EI, DC, LO, LK	Protects and preserves flora and fauna, and natural objects of historical, aesthetic, and scientific importance in the Americas in their natural habitats over sufficiently extensive areas.	Protects and preserves important habitats used by sea turtles throughout their life stages

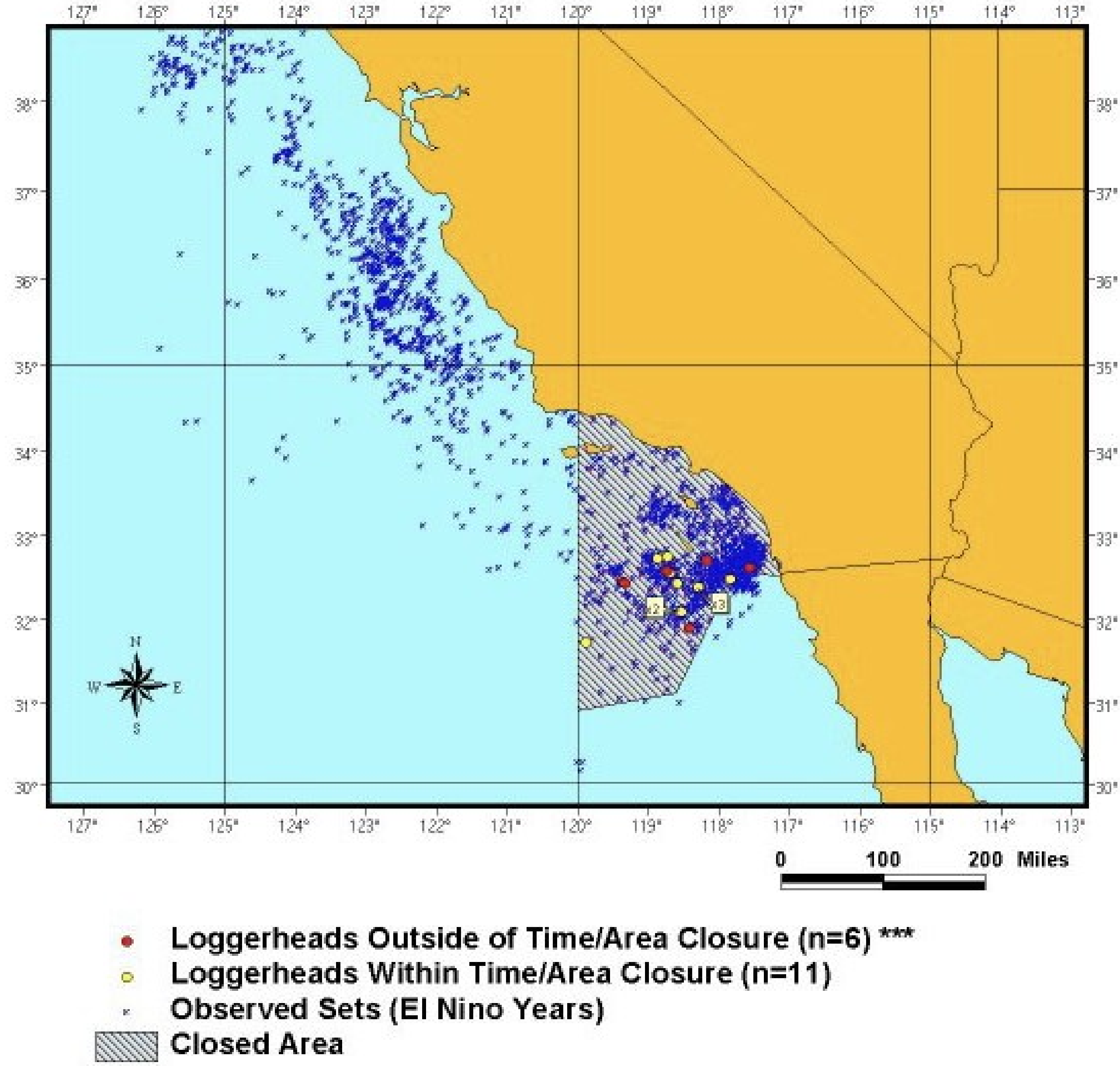

Figure 1. Loggerhead observations (red and yellow dots) within the SCB, and the area that closes to the CDGN during ENSO events (Eguchi, 2015, Ref 23).

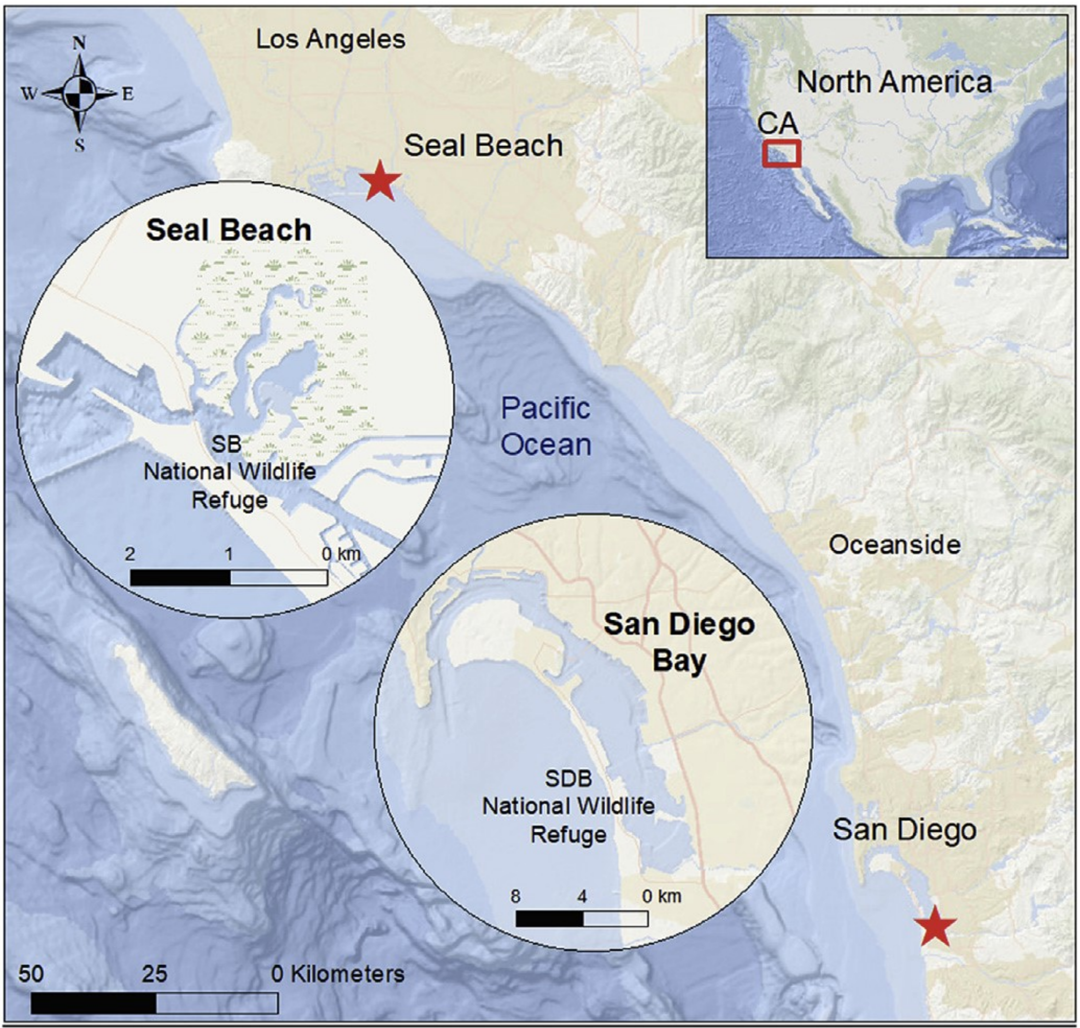

Figure 2. The two green sea turtle foraging sites (red stars) in southern California (CA). Top left circle is the San Gabriel River (SGR) Seal Beach National Wildlife Refuge; bottom circle is San Diego Bay (SDB) (Barraza, et al. 2019, Ref 6).

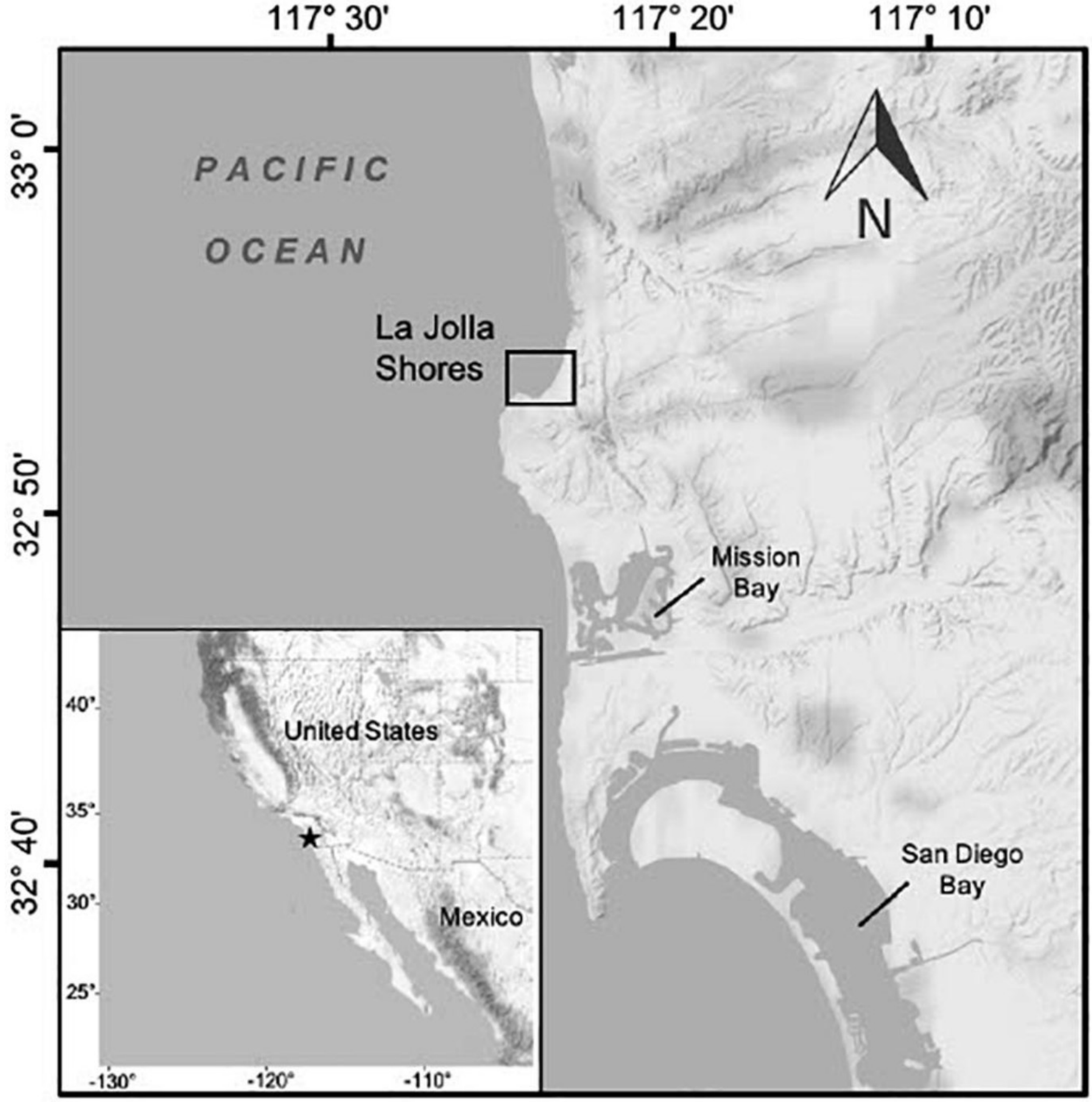

Figure 3. Location of the La Jolla Shores (LJS) green turtle resident population that established in 2015 in San Diego, California U.S.A. (Hanna, et al. 2021).

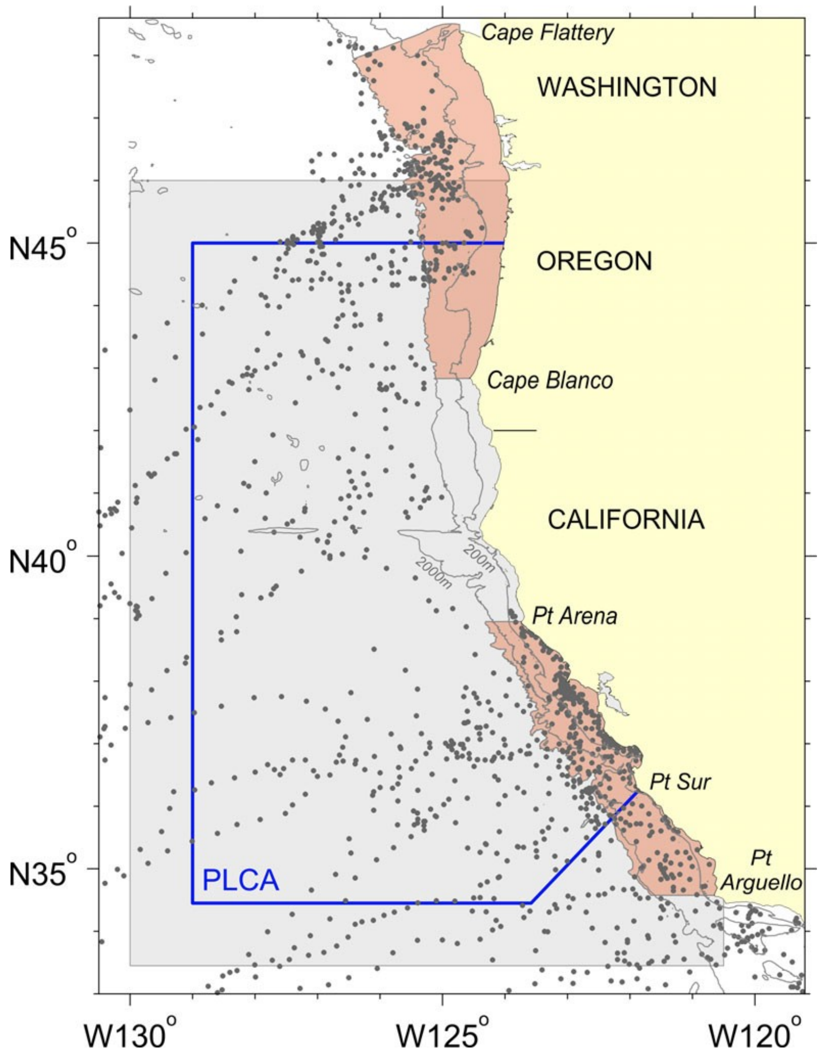

Figure 4. Leatherback telemetry data points (grey circles), assumed foraging areas (light red), and the Pacific leatherback conservation area (PLCA) along the pacific coast of the U.S.A. (Eguchi, et al. 2017, Ref 24).

México

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1. RMU: Green turtle (*Chelonia mydas*) – Eastern Pacific

Part of the information in this chapter was obtained from the Action Program for the Conservation of the Green/Black Turtle species (*Chelonia mydas*) (PACE) (SEMARNAT 2018).

The name of the genus Chelonia was proposed by Brongniart (1800). The species name mydas was first used by Linnaeus (1758). The genus Chelonia is often considered to include the species C. mydas with two subspecies: the black turtle C.m. agassizii (Bocourt 1868) in the Eastern Pacific (from Baja California south to Peru and west to the Galapagos Islands) and the green turtle C.m. mydas (Linnaeus 1758) in the rest of the global distribution range (Groombridge and Luxmoore 1989). However, there is controversy about the taxonomic status of the black turtle as it differs from the green turtle in size, coloration, carapacho shape (Groombridge and Luxmoore 1989) and osteological characteristics (Kamezaki and Matusi 1995). However, the results of some mitochondrial DNA analyses that have been performed do not support the distinction of the black turtle (Bowen et al. 1992).

The black turtle population is distinguished from the green turtle mainly by its size, coloration and shape of the carapace. The carapace of an adult black turtle is narrower and taller. The carapace notch on the posterior fins is more marked in the black turtle (Márquez 1990). The black turtle is notoriously smaller than the green turtle. In Michoacán, the average size of females is 85.7 cm curved carapace length (LCC) (range 60 – 110 cm, n= 1,500) (Delgado 2003). In the Galapagos Islands the average size of nesting females of black turtle is 80 cm (LCC) (Márquez 1990). Adult females weigh from 65 to 125 kg. Adult males in Michoacán are smaller than females with an average of 77 cm of LCC (range 71-85 cm, n = 32) (Figueroa 1989).

In adult green turtles the carapace and dorsal surface of the head and fins are olive green, they can have shades of dark gray or black, while the plastron the shade of color varies from cream-gray to olive-gray or bluish. Generally the plastron has extended spots of gray color. The young have a black to dark gray carapace and a white plastron. They have a white border around the back of the carapace and fins. Juveniles have striking coloration, with a pattern of light colors and brown, reddish-brown, olive and yellow on the back. It is common to find epibionts in the carapace, plastron and fins, which are cirripedian crustaceans. The carapace usually features five central scales, four pairs of side scales, and 11 pairs of marginal scales. (Alvarado y Delgado 2005).

The plastron features six pairs of scales, plus four inframarginal scales on each side. The head has a pair of elongated prefrontal scales and two to four postorbital scales. The margin of the lower jaw is sawn. Each fin has a single nail on the outer edge.

According to information on the taggs and recapture of green turtles (Alvarado and Figueroa 1992), it makes migrations between the southern and northern ends of its range. Recaptures of females that have been marked in Michoacán have been recorded in El Salvador, Guatemala, Nicaragua, Costa Rica and Colombia. Recaptures have also been achieved in Mexican waters, mainly in the Gulf of California and adjacent areas, as well as on the coast of Oaxaca. Recaptures from Central America are more frequent in

El Salvador and Guatemala, while in Mexico they are more abundant in the Gulf of California. Of the 94 recaptures recorded in the period 1989–2000, 44 were by-catches by shrimp vessels.

Most of the recaptures took place very close to shore, probably because most of the commercial fishing in the Eastern Pacific occurs on the narrow continental shelf (Alvarado and Figueroa 1990). The average depth of 13 capture sites was 24.3 ± 5.8 m (range 10 – 72m).

The longest distance recorded for a turtle before its capture was 3,160 km. This turtle was marked in Michoacán and recaptured in Charambira, Colombia. The minimum travel speed of the recaptured turtles was 22.5 km/day (range 8 – 38 km/day, n= 94). A female black turtle that was fitted with a satellite transmitter after nesting in Michoacan was tracked for two months. This turtle traveled to Central America, traveled approximately 2000 km, at an average speed of 33 km / day (Byles et al., 1995). A turtle marked in Michoacán and recaptured in the Infiernillo Channel of the Gulf of California traveled 1,520 km in a span of 246 days (Seminoff et al. 2002a).

1.1. Distribution, abundance, trends

The main nesting sites of the green turtle are located in the state of Michoacán, mainly the beaches of Colola - Motín del Oro and Maruata (Cliffton et al. 1982). There are sites of minor importance in Mexico, such as the coasts of Guerrero, Jalisco, Oaxaca, the Clarión and Socorro Islands (Márquez 1990), however their presence occurs along the Pacific coast in Central America (Cornelius 1982).

Along the Pacific coast of the American continent the green turtle has been reported from British Columbia (Carl 1955). Along with the Dermochelys coriacea, it is the most frequently observed turtle species on the Pacific coast in the United States (Stinson, 1984). In the southern United States, the green turtle is widely distributed in the coastal waters of Mexico and Central America (Cliffton et al. 1982; Cornelius 1982; Alvarado and Figueroa 1990), however, the main green turtle aggregations occur in breeding areas in Michoacán in Mexico. Throughout the year, it occurs in the feeding areas that are located on the Pacific coasts of Baja California, in the Gulf of California and on the coast of the state of Oaxaca.

The Black turtle population in the Mexican Pacific has been monitored since 1982 by the Michoacan University of San Nicolás de Hidalgo in the natural area portegida Colola-Maruata sanctuary, the main nesting site of this population (Playa Indice). According to the nesting activity at this site, the population has been recovering since 2002 and in the last 10 years has shown a considerable increase in the number of nesting females go from an average of 500 females in the decade of the 90s to 15,000 females in 2010-2020, in number of nesting in recent years have exceeded 35 thousand nests (figure 1).

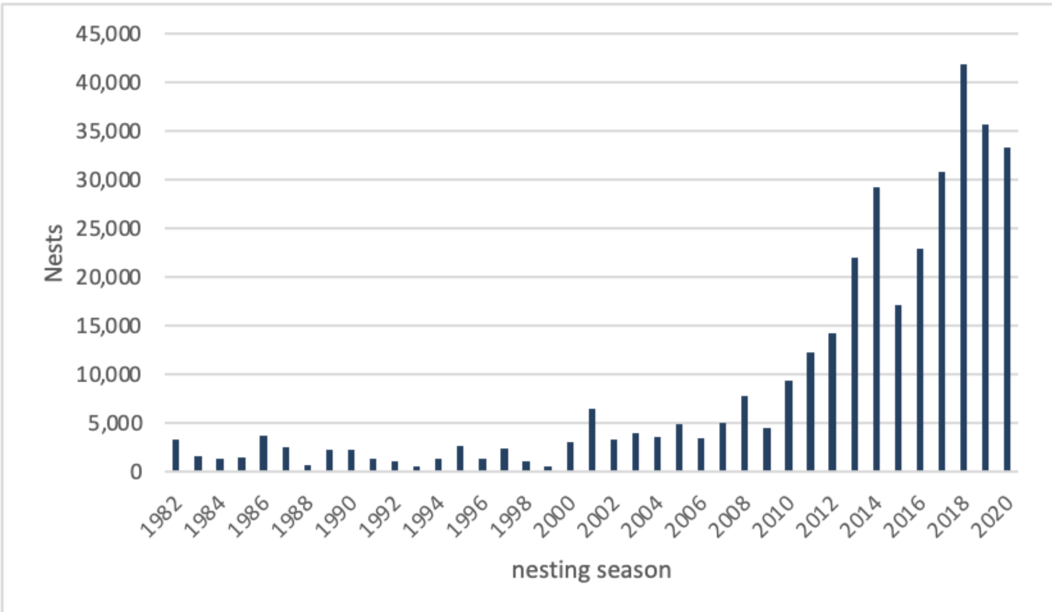

Figure 1. Black turtle protected nest in Colola, Michoacan 1982-2020 period.

1.1.1. Nesting sites

The main nesting areas of Black turtle in the Mexican Pacific are located in Michoacan on a coastline that covers 80 km of coastline, and most of the nesting in this area includes Colola, Maruata, Motín del Oro, La llorona, Paso de Noria, Cachan de

Echeverría, Arenas Blancas, Cuilala and Chocola nesting beaches. (Alvarado and Delgado 2005), however, in the last 10 years important nesting activity of Black turtle has been reported along the Pacific coast of Mexico from Chiapas to Baja California.

1.1.2. Marine areas

The main feeding and development area of the nesting population of Michoacán black turtle is located in the waters of the Baja California Peninsula (Alvarado and Figueroa 1992), where it is estimated that more than 10,000 black turtles, juvenile and adult, are captured annually incidentally and directed (Nichols 2000). Although the coastal feeding areas of the black turtle are not clearly delimited, the main sites appear to be located on the western coast of the Baja California Peninsula (Laguna Ojo de Liebre, Laguna San Ignacio, Bahía Tortugas, Bahía Magdalena) (Cliffton et al. 1982), the Gulf of California, the Upper and Lower Lagoons in Oaxaca (Márquez 1990).

According to information from recaptures, the feeding areas of the black turtle population that nests in Michoacán are in the seas of Mexico and Central America (Alvarado and Figueroa 1990).

The coastal lagoons of Sinaloa and the Infiernillo channel between Isla Tiburón and the coast of the state of Sonora as well as coastal lagoons of Oaxaca, are also feeding and development habitats for green turtles in Mexico.

1.2. Other biological data

Green turtles leave pelagic habitats and join coastal development and feeding areas at a size of approximately 40 centimeters (LRC) in the Baja California Peninsula (Seminoff et al. 2002b). In these areas, green turtles change their diet to items primarily of plant origin. As herbivorous species, the green turtle, occupy a unique food niche among their group, since they consume mainly seagrasses and algae, although they also sometimes come to provide themselves with items of animal origin, especially jellyfish, tunicates and sponges. Casas-Andreu and Gómez-Aguirre (1980) recorded similar components in turtles analyzed on the western coast of Mexico, with *Ulva* being the most abundant algae in food content samples.

In the Infiernillo Channel, located in the area between Isla Tiburón and the mainland, in the Gulf of California, green turtles feed on seagrasses (Zostera marina) and the sea slug (*Aplesia californica*) (Felger and Moser 1987).

1.3. Threats

Commercial exploitation of this species, in its nesting area in Michoacán, began considerably later than in the foraging areas in Baja California. Before the fifties, nesting beaches were in a pristine state as the area was spared and difficult to access. Precisely, during this decade the towns of Maruata and Colola were established. In the sixties the market for skin, eggs and turtle meat developed. In the early seventies, approximately 70,000 eggs were extracted each night during the nesting season in Colola and 10,000 to 20,000 from Maruata Beach (Cliffton et al. 1982).

This extraction continued until the early eighties, when hatcheries were established on the beaches for the protection of nests. But even in the seventies, between 7,000 and 15,000 black turtles were caught annually in Michoacán for the commercialization of their meat and skin (Cliffton et al. 1982).

The directed capture of adults continues to practice in Baja California, Sonora and Sinaloa where turtle meat is still marketed (A. Zavala Pers. Comm.). So far, fisheries by-catch assessments are scarce.

The number of habitants on the Michoacan coast has increased markedly during the last 20 years, as well as the number of visitors from other regions. This expansion has resulted in increased pressure on coastal resources, including the sea turtle. The main risk of increased human presence on beaches is disturbance of nesting females.

The most important threat on nesting beaches in Michoacán is the harvest of eggs The proportion of nests harvested from black turtles on the beaches of Maruata represent between 10 and 15%, and on Colola beach between 5% to 8% of the total nests per season; while the beaches of Paso de Noria, Cachan de Echeverría, Ximapa, Motín del Oro, La Llorona and Cuilala nesting beachs register 40% to 50% of harvested nests (Alvarado and Delgado 2005).

1.3.2. Marine areas

Fisheries by-catch assessments are scarce or non-existent. However, the capture of individuals in feeding grounds and migratory corridors in the Mexican Pacific either by directed capture or bycatch we know occurs through anecdotal cometaries of fishermens.

1.4. Conservation

For the protection of sea turtles, the Government of Mexico has issued and monitored compliance with various legal regulations such as laws, decrees and agreements that protect the species that inhabit the territory. It includes vedas, creation of natural areas for the conservation of species, elaboration of Norms that involve sea turtles, as well as the creation of Laws. Within the framework of the National Programme for the Protection and Conservation of Sea Turtles, on 2 December 1993 the Inter-Secretarial Commission for the Protection and Conservation of Sea Turtles was created on a permanent basis, with the aim of coordinating the actions of the federal public administration agencies in the research, protection, conservation and rescue of sea turtles.

In the same year, the National Committee for the Protection and Conservation of Sea Turtles was formed, composed of representatives of the productive, academic and governmental sectors. Since 1997 neither the Committee nor the Commission has been active and their current situation is unknown. It is important to seek the updating of these figures because they represent tools of work and coordination of the actors involved in the conservation of sea turtles involving the new instances of all levels of government that have been created since then. In this sense, the Action Programs for the Conservation of Species will fulfill this function.

On November 29, 2006, the Decree was published reforming, adding and repealing various provisions of the Internal Regulations of the Ministry of Environment and Natural Resources. There it is established that the National Commission of Protected Natural Areas will be in charge of coordinating the National Program of Conservation of Sea Turtles from the General Directorate of Regional Operation. In the same document, it is stated that the General Office of Wildlife will be responsible for determining the policy on priority species and populations in close relationship with the instances of the Secretariat involved in the issue (Programa de Accion para la conservación de la especie Tortuga Verde/ Negra (Chelonia mydas) - SEMARNAT, 2018).

As part of the actions for the recovery and conservation of sea turtles, Mexico has established various multilateral and bilateral international agreements. These include:

1. The International Convention on Trade in Endangered Species (CITES) which lists the species Chelonia mydas within Appendix I.
2. The Inter-American Convention for the Conservation of Sea Turtles in the Western Hemisphere (IATTC) of which Mexico was a promoter for its interest in the conservation of sea turtles.
3. The Canada-Mexico-United States Trilateral Committee for the Conservation and Management of Wildlife and Ecosystems, through projects promoted by the North American Commission for Environmental Cooperation.

As part of bilateral cooperation we have Binational Meeting of Fisheries Authorities and the MEXUS Memorandum of Understanding.

a. The Convention on Biological Biodiversity.

b. The Ramsar Convention.

1.5. Research

As part of the investigation actions, the National Commission of Protected Natural Areas (CONANP) Proposed a series of research works on green turtles in the Program of Actions for the Recovery of Species at Risk (PACE) (Semarnat 2018) aimed at:

Promote and conduct research on the biology and ecology of the green turtle and its habitat, as well as the risks faced by its populations at the regional level, which result in effective actions for its protection, management, conservation and recovery.

1. Describe the reproductive biology and demography of the nesting populations of the species,
with emphasis on reproductive potential and brood recruitment.

2. Conduct studies on ecology and genetics of green and black turtle populations to determine management units for conservation.

3. Generate and describe maps of the main threats and risks affecting green and black turtle populations.

4. Identify and evaluate the impacts of tourism at nesting sites on the behavior of females, nests and offspring of the species in the regions to improve conservation programs.

5. Complement studies on the health status of green turtle populations.

6. Carry out studies to determine possible contamination in the nests of the species by pesticides and hydrocarbons.

7. Study the movement of juvenile and adult green and black turtles using satellite tracking.

8. Determine the impact of commercial fisheries on bycatch on the green turtle.

9. To determine the impact of scale fisheries in the Mexican Pacific Northwest on the green turtle.

10. Conduct demographic and mortality censuses in green turtle feeding habitats of Sinaloa and Baja California to assess trends in different demographic segments of the

population in development habitats (long term).(Programa de Acción para la Conservacion de la especie Tortuga Verde/Negra Chelonia mydas - SEMARNAT 2018).

2. RMU: Loggerhead turtle (*Caretta caretta*) – North Pacific

The information contained in this chapter was obtained from the Program of Action for the Conservation of the Species Loggerhead Turtle (Caretta caretta) (PACE)(SEMARNAT 2018). In the Mexican Pacific there are not records of nesting areas of loggerhead turtle (*Caretta caretta*) however, there is a very important feeding area for this species in the Gulf of Ulloa of the Pacific coast of the Baja California Peninsula. More than 40 years ago, the Federal Government began the conservation of sea turtles of the coast of Mexico. Among the most relevant actions, the Mexican government included, in addition to the other species of sea turtles, the loggerhead turtle (*Caretta caretta)* in the Official Mexican Norm (NOM-059-SEMARNAT-2010) as an endangered species. Likewise, the species has been included in the lists of taxa at risk at the international level: it is found in Appendix I of the list of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), and in the Red List of the International Union for Conservation of Nature (IUCN) as "Endangered. This species of sea turtle is distributed in both coasts of the Mexican Republic, however the habitats they occupy are different and the problem as well. The loggerhead turtle nests on the coasts of the Gulf of Mexico and the Mexican Caribbean, with the area with the highest nesting density being the coast of the State of Quintana Roo. On the Mexican Pacific coast, the species does not have nesting areas; the identified population of loggerhead turtle in Baja California Sur (locally known as the yellow turtle) consists of juveniles and subadults belonging to the nesting population in Japan. Its distribution covers the entire North Pacific, but remains most of its life cycle in the breeding area near the coast, in the Baja California Peninsula (Nichols 2003; Seminoff et al. 2006).

2.1. Distribution, abundance, trends

There is evidence that the loggerhead turtle was once very abundant on the coasts of the Gulf of California and the Pacific coast of Baja California; there have been no records of sexually mature individuals, so the area is considered an area of development and growth (Cliffton et al., 1981). The Seris recognize two ethnospecies of loggerhead turtle in their region, and in the past fishermen knew it as "mestizo loggerhead", with a market value much lower than that of the green turtle since they considered that its meat was not of quality.

According to genetic and satellite telemetry studies, it is considered that all the specimens of loggerhead turtle observed in the waters of the Mexican Pacific come from the breeding populations that nest in the Japanese archipelago (Bowen et al. 1995; Nichols et al. 2000). For this reason, all individuals observed in Mexican waters are juvenile or pre-adult individuals who have made a migration across the Pacific to travel about 12,000 kilometers. The number of juvenile loggerhead turtles present in Mexican waters has been estimated at tens of thousands (Seminoff et al. 2006); however, because certain important aspects about the dynamics of this population are unknown, it is difficult to know if this number of juveniles will increase nesting on Japanese beaches in the near future.

2.1.1. Nesting sites

No loggerhead turtle nesting sites have been reported in the Mexican Pacific.

2.1.2. Marine areas

No loggerhead turtle nesting has been reported on beaches in the Mexican Pacific, but an important feeding area located off the coast of the Baja California Sur peninsula (Gulf of Ulloa), particularly between Punta Eugenia and the Bahía Magdalena lagoon complex in the so-called Gulf of Ulloa, have been reported. This site presents oceanographic conditions that induce high productivity and biodiversity, presenting a high concentration of prawn (Pleuroncodes planipes), the main source of food for the loggerhead turtle in this region. Apparently this is an important cause of these animals being attracted forming areas of aggregation (Ramírez-Cruz et al. 1991; Aurioles-Gamboa 1995; Peckham and Nichols 2002). The biological oceanography of these two habitats differs fundamentally in terms of temperature, productivity and current regimes, as well as the variability of each of these factors. The oceanic environment of the north-central Pacific is characterized by a lower primary production of chlorophyll a, lower surface temperatures (5-26º C) and a strong seasonal variability in relation to the neritic habitat of Baja California (Polovina et al. 2001; Kobayashi et al. 2008). Differences in the biological oceanography of the two habitats result in differences in the movement and diet patterns observed in turtles. Consistently higher primary productivity in Baja California's neritic environment likely translates into a greater abundance of prey. Recent studies of telemetry and aerial censuses allowed to determine that juvenile loggerhead turtles are concentrated in an area of 15,194 km^2 with their center only 32 km from the coast of Baja California Sur (Peckham et al. 2007).

2.2. Other biological data

The loggerhead turtle is a highly migratory species with a complex life cycle that is characterized by various juvenile stages that occupy diverse habitats, from exclusively oceanic to neritic, with adults making migrations to nesting beaches (TEWG 2009). It is considered the species of sea turtle of the Family Cheloniidae that is distributed in colder areas (Hawkes et al. 2007). It is carnivorous throughout its life cycle. Its thick beak, broad head and strong jaws can crush the shells of large mollusks such as those of the genus Strombus. They spend their early years in the convergence zones of currents in the open sea, where they feed on various small invertebrates such as crabs. Large juveniles and adults have a more varied and opportunistic diet. In the pelagic environment they can feed on salps, jellyfish and other floating invertebrates, while in coastal areas they prefer crustaceans and mollusks (Ruckdeschel and Shoop 2006).

2.3. Threats

In Baja California Sur, there is no strictly traditional use of sea turtles, however, in fishing communities there is the deep-rooted custom of meat consumption at parties and social events. Particularly in the most marginalized and remote communities, turtle meat was an important resource that gave variety to the diet in years past. The belief that fresh turtle blood is "toning" is also widespread locally (Maldonado et al. 2009). In general, in northwestern Mexico, turtle meat is still considered an exquisite dish and, consequently, illegal capture in feeding areas remains a major threat that is favored by the poor protection of feeding and development areas. It has been estimated that up to 67% of the mortality of loggerheads found on beaches and coastal communities in the Mexican Pacific is attributable to human consumption (Koch et al. 2006).

2.3.1. Nesting sites

N/A

2.3.2. Marine areas

In the Pacific, the main fishing techniques that incidentally catches loggerhead turtles are gillnets and bottom shoring that riparian fishing fleets use to exploit sole or shark (Maldonado et al. 2005; Peckham et. al. 2007). Bycatch of juveniles was high in the north-central Pacific region until a ban was established in 1991 (Wetherall et al. 1993), and remains high on offshore longliners (Lewison et al. 2004). However, bycatch is currently considerably higher in the coastal area of the Baja California peninsula due to riparian fisheries (Peckham et al. 2007; Peckham et al. 2008).

2.4. Conservation

For the protection of sea turtles, the Government of Mexico has issued and monitored compliance with various legal regulations such as laws, decrees and agreements that protect the species that inhabit the territory. It includes vetoes, creation of natural areas for the conservation of species and elaboration of norms and laws that involve actions for the conservation of sea turtles. On 29 November 2006, the Decree reforming, adding and repealing various provisions of the Internal Regulations of the Ministry of the Environment and Natural Resources was published. There it is established that the National Commission of Protected Natural Areas will be in charge of coordinating the

National Program of Conservation of Sea Turtles from the General Direction of Regional Operation. The same document states that the General Director of Wildlife will be responsible for determining the policy on priority species and populations in close relationship with the secretariat bodies involved in the issue (Programa de Accion para la Conservación de la especie Tortuga Caguama (*Caretta caretta*) - SEMARNAT, 2018).

2.5. Research

The research and conservation work of loggerhead turtles in the Mexican Pacific is very recent compared to that which has been developed in the Gulf and the Caribbean. Since 1990, the first studies were initiated to evaluate the presence and abundance of this species in the area (Ramírez-Cruz et al. 1991; Olguin 1990; Villanueva 1991). In 1997, during periodic tours of San Lázaro beach, approximately 43 km between López Mateos and Punta San Lázaro, the stranding of numerous turtle remains was recorded. Over the next few years, an alarming increase in the number of stranded dead loggerhead turtles was found, concluding that bycatch in local fisheries may be contributing significantly to the observed mortality of loggerheads and causing a greater impact on the Pacific population of this species (Nichols 2003). In 2001 started the Caguama Project (ProCaguama) formalizing the census on San Lázaro beach. Starting in 2003, daily censuses were conducted during the summer and two per week in the rest of the year; during these an average of 500 carapaces per year was recorded in the 43 km, one turtle dead every 4 km per day in summer season, which is temporarily related to the local fishing of scale species. This is the highest frequency of strandings reported globally (Peckham et al. 2008). Starting in 2003, Procaguama set itself the objective of evaluating and mitigating the mortality of Loggerhead turtle in Baja California Sur, initiating a program to raise awareness and search for solutions to the incidental capture of loggerhead in the area. Its goal has been to empower local fishermen to analyze the issue in an informed manner and act according to a new perspective. As part of this project, from 2003 a pride campaign focused on the community of López Mateos began, of which an essential element is the development of the Caguama Festival, expanding to other communities from 2004. As part of the Caguama Project, between 1996 and 2005, satellite marks were placed on 30 loggerheads, which made it possible to identify an area of aggregation that overlaps significantly with the perimeter of range of the riparian fishing fleets (Peckham et al. 2007). This pattern of turtle distribution was confirmed from aerial censuses conducted in 2005 and 2006 (Seminoff et al. 2006). Using a Monte Carlo model, Peckham et al. (2008) estimated that between 1,500 and 2,950 loggerhead turtles died between 2005 and 2006 as a result of incidental catch during the operation of two riparian fishing fleets, which is a substantial increase over previous years. This population of loggerhead turtle comes from the nesting population of Japan, so to achieve its recovery, conservation actions have been required at the international level. Nesting beaches in Japan are protected (Matsuzawa 2007); there is a strict regulation in tuna fisheries in the United States that establishes a maximum catch quota of 17 turtles per year to an entire fleet of 120 vessels which, if exceeded, causes the temporary suspension of fishing activities (Programa de Accion para la Conservación de la especie Tortuga Caguama (*Caretta caretta*) - SEMARNAT, 2018).

3. RMU: Leatherback turtle (*Dermochelys coriacea*) Eastern Pacific

The information in this chapter was obtained from the Action Program for the Conservation of the Leatherback Turtle (*Dermochelys coriacea*) – SEMARNAT 2018. The leatherback turtle is the most oceanic of the sea turtles and therefore, one of the least known. It is the largest marine reptile in existence; in the Caribbean they can measure up to 178 cm. (curved length of the carapace) and weigh up to 500 Kg. (Boulon et al. 1996). The leatherbacks of the Mexican Pacific, are smaller, reaching an average size of 142 cm. of curved carapace length (Sarti et al. 2007).

It lacks scales on the entire body, which is covered with a soft skin of coriace texture, black mottled with white. The carapace is slightly flexible, composed of a mosaic of small dermal bones; the ribs are thin and lack pleural ridges, keeping the whole life of the organism separated. It has seven longitudinal keels in the carapace and five in the plastron. On the dorsal part of the head they have a pink spot characteristic of each individual and that can be used as an individual identification mark. It also has no nails (Pritchard 1971). Adults present numerous adaptations to cold waters: their body temperature is maintained several degrees Celsius above room temperature thanks to a subepidermal layer of fat, the thermal inertia given by its large size (Frair et al. 1972; Paladino et al. 1990) and a contracurrent arteriovenous mechanism located in the forefront fins that prevents heat loss through the skin (Greer et al. 1973).

They can perform dives up to 1,000 m deep and stay in the dive for approximately 15 minutes (Eckert et al. 1989). Due to an arterio-venous system of countercurrent, its subepidermal layer of fat, great muscular activity and thermal inertia due to its size, it is able to maintain its body temperature up to 18 ° C above the temperature of the water, so it can inhabit very northern or southern seas. However, it always looks for tropical areas during its reproductive season. Its nesting season in the Eastern Pacific is from October to April, although it has been rarely observed in July, August or September; spawns five times on average although up to 12 layings per female have been recorded in a season, and lays 62 eggs on average; hatching success is generally lower than the other species still under in situ incubation conditions. (Sarti et al. 2007).

3.1 Distribution, abundance, trends

Leatherback turtle It is a species with wide worldwide distribution. In Mexico we find it along the Pacific with areas of greater density in the states of Michoacán, Guerrero and Oaxaca. Between each nesting it remains relatively close to the coast and usually nests on the same beach each time, but sometimes it moves for more than 400 km to do it on another beach. It is considered a species of weak philopatry (Dutton et al. 1999); during the 1998-1999 season a female was found nesting on the beach of Tierra Colorada that had been marked in Playa Grande, Costa Rica in 1995. (Sarti et al. 1999). For nesting, he prefers open, low-sloped and unobstructed beaches (Pritchard 1971; Mortimer 1981a).

The distribution and abundance of annual nesting throughout the Mexican and Central American Pacific is currently known. Abundance monitoring has been carried out in a systematic and standardized manner throughout the region since the 1995 season. According to their abundance, two categories of importance of nesting beaches are considered: (1) Priority Beaches and (2) Occasional or rare nesting beaches:

1. Priority Beaches I.- Beaches with density and abundance of nesting outstanding from the others and maintained over the years. These beaches are considered index beaches in the monitoring program: Mexiquillo in Michoacán, Tierra Colorada in Guerrero, Cahuitán and Barra de la Cruz, Oaxaca.
Another area of primary importance in the Eastern Pacific is located in Costa Rica, the area of Las Baulas National Park, on the Guanacaste Peninsula.

2. Priority II Beaches.- Beaches with important nesting density, but not so outstanding: Agua Blanca, and Los Cabos, BCS, Playa Ventura, Gro., La Tuza, San Juan Chacahua, Chacahua Bay and Cerro Hermoso, Oaxaca.

As a whole, only the primary beaches host about 45% of the total nesting of the Mexican Pacific in a total extension of 62 km of coastline. Among the priority and secondary beaches is 70% to 75% of the total nests in 245 km (Sarti et al. 2007).

The population of the eastern Pacific was long considered the largest in the world, estimating at the beginning of the 80's that the Mexican Pacific area was home to 65% of the world's population (75,000 females estimated then). Currently in Mexico this species is listed as Endangered in NOM-059-SEMARNAT-2001. However, because most of the known populations in various parts of the world show a drastic decline of more than 80% in less than 20 years, so the leatherback turtle is currently classified by the IUCN As Critically Endangered (Programa de Accion para la Conservación de la especie Tortuga laud (Dermochelys coriacea - SEMARNAT, 2018) .

El Playón de Mexiquillo, Michoacán is the only beach in Mexico that has a complete and continuous information base since 1982 so it is considered an index beach. On this beach, as in others in the world, the reduction of the population has been evident: from around 4,000 nestings registered in the mid-80's (1,000 estimated females) in the first 4 km to the SE of the beach, less than 100 nests were registered at the beginning of the 90's, which represented 16 nesting females for the 18 Km., total length of this beach. This means a reduction of more than 95% in the size of the nesting population on this beach in a decade. The total number of nests for those years of great abundance has been estimated and corrected, so that only less than half of the beach was traveled (Sarti et al. 2007). This shows an even more drastic reduction, from about 12,000 nests in the mid-80's, to less than 100 in 1993.

The total number of nests per beach per season is used as an abundance index of the population. Although there are no continuous works in the rest of the main beaches of the Mexican Pacific, the available information indicates that the reduction in the population has been similar. It can be seen that from the beginning of the 90's the population follows a trend of decline, with a cyclical pattern of good years interspersed with bad years, given perhaps by the triennial reproductive cycles of leatherbacks. However, it is generally observed that a given good year is not as good as the previous good year, and a bad year is worse than the previous bad year. This indicates that the population is in a delicate situation, and the decline still continues despite the protection efforts made so far.

3.1.1 Nesting sites

The Leatherback turtle is widely distributed in the south central area of the Pacific coast in Mexico, the coasts of the state of Oaxaca (Cahuitan, Barra de la Cruz, La Tuza, Chacahua Bay and San Juan Chacahua), Guerrero (Tierra Colorada and Playa Ventura) and Michoacán (Mexiquillo and Manzanilla) receive the highest density of leatherback turtle nests in the Mexican Pacific, however, nesting has been reported from Chiapas to the Baja California peninsula (Agua Blanca and Los Cabos).

3.1.2. Marine areas

3.2. Other biological data

The leatherback turtle is a long-lived species, which takes an estimated time of sexual maturation of 14 – 20 years (Zug and Parham 1996), with a high degree of specialization since it feeds exclusively on jellyfish and zooplankton, although the occasional presence of remains of fish, crustaceans and chlorophytic algae has been recorded in the stomach contents of the leatherback turtle (Den Hartog and Van Nierop 1984). Although it has the highest fertility rate of all sea turtles, measured as annual egg production, mortality in offspring is high. It is the largest species among sea turtles, and body size has been shown to be directly related to the risk of extinction (Begon et al. 2006). These characteristics of her life story make her highly vulnerable.

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3.3. Threats

Various threats to females, nests and young have been detected both on nesting beaches and in the marine areas they habit, which are attributed to the decline of populations in Mexico.

3.3.1. Nesting sites

The poaching of eggs and the killing of females on nesting beaches. Despite being illegal, it is a common practice on most nesting beaches. It is estimated that before the protection programs established on the beaches index in the 80's, the looting of eggs was up to 100%, with which the production of offspring was almost zero (Sarti et al. 2007). This situation still continues on beaches of minor importance that do not have protection programs and surveillance actions. On some beaches the females kill themselves to get the egg without waiting for the turtle to make the nest. Elsewhere females are slaughtered to obtain the oil as it is considered as a traditional medicine against respiratory diseases; meat is occasionally used as food by coastal populations. Eggs, although they are a food source for local people, are generally obtained as a quick source of income that solves their immediate problems despite the risk of being caught with turtle eggs. The penalty is currently 1-12 years in jail without bail.

3.3.2. Marine areas

Bycatch.

There is evidence that the eastern Pacific leatherback population is strongly affected by longline, drift net, trawl and purse seine fisheries mainly in both national and international waters. Female leatherback turtles have been documented that bore Mexican markings and were incidentally caught on Chilean longlines (Frazier and Brito-Montero, 1990). On the other hand, the boost that Chile gave to the longline swordfish fishery in the 80's coincides with the beginning of the collapse of the nesting population in Mexico (Eckert and Sarti 1997). Leatherbacks do not normally bite baits, but are hooked on hooks and longline lines, or are caught in gillnets and driftnets. The mortality rate in these incidents is unknown. There is also no information available on the bycatch rate in the Mexican longline and gill fleet.

2. Direct take.

Although the meat is not highly prized, the laud turtle has been caught for sale of its meat as beef, family consumption or use as bait in the artisanal shark fishery in certain areas. Turtles are harpooned and slogged in the sea, so the incidence of these actions is very difficult to evaluate (Program of Action for the Conservation of the Species Leatherback Turtle (*Dermochelys coriacea*)- SEMARNAT 2018).

3.4. Conservation

Since 1995, the leatherback Project has been responsible for establishing a population monitoring program with standardized methods on the most important beaches for the nesting of the leatherback turtle in the Mexican Pacific. Currently, several types of marks (metallic and electronic) are used to identify females and learn about various aspects of their reproductive biology and their movements between nests. This knowledge has increased the accuracy of estimating the size of the nesting population, allowing to compare abundance, fertility, incubation success, and distribution between beaches and over time.Through the dissemination of the problem, it has been possible for various programs carried out by government, federal or state agencies, NGOs and local communities to get involved in protection activities on beaches of secondary importance and even in some where nesting is occasional. Programs that were dedicated to the protection of the Olive Ridley Turtle Lepidochelys olivacea whose period usually ends in December, have extended their stay on the beach until March to be able to protect the few nests they have of lute and release the offspring.

On 17 September 2003, the Tri-State Convention for the Recovery and Conservation of the Leatherback Turtle in the Eastern Pacific was signed. This agreement was signed by the governors of the states of Michoacán, Guerrero and Oaxaca, as well as the Secretary of the Environment and Natural Resources. Its main objective is to design and establish measures for the conservation and recovery of the Eastern Pacific leatherback turtle population and the habitat on which it depends, based on the available scientific data and considering the environmental, socioeconomic and cultural characteristics of the parties. This agreement establishes that, in order to achieve the recovery of the leatherbacks of the Eastern Pacific, comprehensive attention must be given to terrestrial and marine factors, there must be coordination between the three levels of government, joint mechanisms must be developed for the conservation and restoration of nesting beaches, a reduction in bycatch of leatherback during fishing activities must be given, as well as detecting socioeconomic factors of riparian communities that affect the success of the conservation of nesting females and their eggs.

The establishment of the Network of Communities for the Protection of the Leatherback Turtle arises as part of the agreements taken by the Technical Committee of the Tri-State Convention. This network establishes a bridge of communication between the communities living in the priority areas for the conservation of the leatherback turtle and the authorities of the three states and the federal government, in addition to promoting the exchange of experiences and awareness.

The leatherback project arises as a response to the decline observed in 1993. It is a coordination project between different institutions and organized groups that carry out conservation actions in the different beaches of the Mexican Pacific with the aim of carrying out the best conservation practices through standardized methods, sharing information, having a single database and making an annual report that shows the situation of the lut population in the Mexican Pacific and its trends (Programa de Accion para la Conservación de la Especie Tortuga Laud (Dermochelys coriacea) – SEMARNAT 2018).

Under the Tri-State Convention, the Leatherback Project has held five meetings with people from coastal communities in the three states with the most important beaches. Some of the most relevant conclusions of the 4th and 5th Workshops are the following:

1. The Leatherback Project must be inter-institutional, and requires a shared responsibility between the different organizations and institutions.

2. It must be interdisciplinary and inclusive, with the participation of local communities, authorities and academics.

3. It must integrate the information generated by the various monitoring and research programs. The scientific part must provide elements to enrich conservation efforts.

4. It should include the involvement of authorities at different levels.

5. It must optimize resources and focus them in an efficient way.

6. It must define actions in the short term (1 year), medium term (5 or 6 years) and long term (10 to 50 years).

7. The project should place emphasis on the protection of the habitat of the leatherback turtle as well as the protection of individuals.

8. The leatherback turtle is an umbrella species so by conserving it we are conserving other species.

9. There is a need for a greater number of professionals who have a training in the proper management of sea turtles

10. It is important to incorporate community development into leatherback turtle conservation strategies

As part of the actions for the recovery and conservation of sea turtles, Mexico has established various multilateral and bilateral international agreements. These include:

a. The International Convention on Trade in Endangered Species (CITES) listing the l eatherback turtle in Appendix I

b. The Inter-American Convention for the Conservation of Sea Turtles in the Western Hemisphere (ILC), of which Mexico was a promoter for its interest in the conservation of sea turtles. During the second Conference of the Parties, resolution COP2/2004/R-1 resolution on the conservation of leatherback turtles (Dermochelys coriacea) was adopted, calling upon

Parties to take all necessary measures to prevent the continued decline of this species and to take actions to promote its recovery.

c. The Canada-Mexico-United States Trilateral Committee for the Conservation and Management of Wildlife and Ecosystems, through projects promoted by the North American Commission for Environmental Cooperation, has the North American Plan of Action (NACAP) for the conservation of the leatherback turtle. This establishes priority actions to be carried out both on nesting beaches including habitat protection and at sea in order to achieve the reduction of the incidental catch of this species.

d. As part of bilateral cooperation we have the Binational Meeting of Fisheries Authorities and the MEXUS Memorandum of Understanding, where joint actions have been established for the conservation of the leatherback turtle (Programa de Accion para la Conservación de la Tortuga Laud – SEMARNAT 2018).

3.5. Research

As part of the recovery strategies of the laud turtle population in the Pacific in Mexico, research and monitoring activities of the population have been proposed within the strategic plan of the program of action for the conservation of the species Leatherback turtle (*Dermochelys coriacea*). (SEMARNAT 2018) that aims to:

1. Increase knowledge about the factors that have caused the decline of the leatherback

turtle in the Mexican Pacific in order to develop effective prevention mechanisms

3. Obtain biological and ecological information needed to improve conservation programs

To achieve these objectives, the following conservation activities have been proposed:

a. Conduct studies on the potential sources of mortality in the different phases of the life cycle and determine the best methods to combat them.

b. Implement an observer program aboard longline, gill, and trawler vessels, using standardized protocols with other observer programs in the Eastern Pacific region

c. Conduct population genetics studies to determine the possible effect of population size reduction on population genetic variability and genetic relationships between different nesting beaches.

d. Study the movements of females between nestings using telemetry, to identify areas of f requent use in the marine habitat. and long-term movements in its range of distribution.

e. Develop population abundance estimation models for the entire range of the species' distribution in the eastern Pacific.

f. Develop models to estimate survival rates of offspring and juveniles to reproductive adults in the Mexican Pacific population.

g. Maintain abundance monitoring to know population trends along the eastern Pacific by marking females to saturation on all priority beaches and counting nests in order to evaluate important reproductive parameters in the population

h. Maintain monitoring of the physical conditions of nesting females to identify disease incidence.

i. Identify changes in recruitment over time on priority beaches; a significant decrease in brood production that cannot be explained by management problems could indicate physiological or genetic problems in breeding adults.

j. Establish a project to monitor the presence of contaminants in adults, eggs and offspring on priority beaches, in order to identify and alert on possible damage.

k. Monitor environmental parameters on priority beaches to identify early climate changes that affect the percentage of hatching and propose relevant management measures.

4.RMU: Olive ridley (*Lepidochelys olivacea*) Eastern Pacific.

The information of this chapter was obtained from the Action Program for the Conservation of the Olive Ridley Turtle (*Lepidochelys olivacea*) - SEMARNAT 2018.

4.1 Distribution, abundance, trends

In Mexico, the Olive Ridley Turtle is distributed throughout the Pacific coast (Márquez et al. 1976; Marquez and Van Dissel 1982; Zavala et al. 2008; Rodríguez et al. 2010), currently having its largest nesting concentration areas in the state of Oaxaca.

There have been 116 beaches with Olive Ridley Turtle nesting, 98% of them correspond to solo nesting beaches. However, its presence occurs practically throughout the Pacific coast (Márquez et al. 1976). The Olive Ridley Turtle is considered the most abundant species of sea turtle in the world. In 2008 it was classified by IUCN as vulnerable; however, in nom-059-Semarnat-2010 it remains endangered for Mexico.

In the early 2010s, an important increase in the number of nests registered for the species was reported in Mexico (Márquez et al. 2002), although this significant increase in populations has been reported, there is still little information about abundances and densities in numerous sites of its distribution.

In an effort to have an approximate number of individuals of this species in the Eastern Pacific from Mexico to Panama, Eguchi et al. (2007) estimated an abundance at sea around 1.1 million individuals (95% confidence interval: 330,000 – 2 million) in 1998, and 2.9 million (95% confidence intervals: 840,000-5.8 million) in 2006. Average abundances in the sea are reported estimated at around 1.39 million individuals per year in the Pacific. This dramatic increase in the populations of Olive Ridley Turtle in the Pacific is a sign of the resilience of this species of Chelonidae, as well as the efficiency of a series of conservation strategies of the species, such as turtle exclusion devices and surveillance on nesting beaches, which maintained in the long term have provided these results (Márquez et al. 2002).

The increase in the number of nests registered and protected on nesting beaches, as well as the populations of this species began immediately after the decree of total closure of the year 1990 on the capture of sea turtles in Mexico. By 2003, the number of Olive Ridley Turtle nests in Mexico had increased markedly, a phenomenon attributable to the significant decrease in the killing of nesting females, as well as the protection of females, clutches and offspring on nesting beaches.

4.1.1 Nesting sites

Olive Ridley Turtle nesting beaches in Mexico are found all over Mexico's Pacific coast from Chiapas to Baja California. However, the massive aggregations and nestings known as Olive ridley Arribadas in the Escobilla beach in Oaxaca, Morro Ayutla, the Ixtapilla in Michoacan and considerable nesting in El Verde Camacho nesting beach in Sinaloa state.

4.1.2. Marine areas

On the feeding areas there is little information. Cliffton et al. (1995), Márquez (1976), points out that the Olive Ridley Turtles of Mexico come to feed in different regions of our country, in Central America and can reach Ecuador. Casas-Andreu and Gómez-Aguirre (1980), as well as Hess et al. (2008) consider the Olive Ridley Turtle as a mainly carnivorous species, which feeds on crustaceans, mollusks and other benthic organisms that they obtain in coastal areas. During migrations their diet includes pelagic organisms such as red prawns (Pleuroncodes sp.), jellyfish, tunicates, fish eggs, etc. (Márquez et al. 1976).

Regarding migratory routes, information is also scarce, but it is generally recognized that a significant number of individual turtles feed in an area of high primary productivity in the central North Pacific (Dutton et al. 1999; Polovina et al. 2004). In 1999, satellite transmitters were placed on two females that nested in arrival conditions at the Playa de Escobilla Sanctuary, and both turtles traveled southeast around the Gulf of Tehuantepec, and then approached the coast again until they reached Central America. Kopitsky et al. (2000) reported placing transmitters on three females mating off the coast of central Pacific of Mexico; one of them traveled 681 km as the crow flies until she reached the Playa de Escobilla Sanctuary, and the other traveled until she reached the beach of El Ostional in Costa Rica, where she was registered participating in an arribada. For their part, Sanders et al. (2011) and Tiburcio (2010, 2011, 2012) gave satellite tracking to seven females of this species from Baja California Sur; all migrated south, and some of them settled off the coast of Mazatlan Sinaloa, so they suggest that individuals of this species do not leave Mexican waters. Marquez and van Dissel (1982) reports that females marked between 1968 and 1982 in Oaxaca with monel and inconel steel staples were recaptured in Southern California, USA; in several states of the Mexican Pacific, from Baja California Sur to Chiapas, and in some countries of Central and South America reaching Colombia and Ecuador (Márquez et al. 1976; Albavera 2007).

4.2. Other biological data

The Olive Ridley Turtle belongs to the smallest genus of the family Cheloniidae. It is characterized by having an almost circular carapace, with a length ranging from 67 cm to 78 cm; the width of this is about 90% of its straight length (Márquez et al. 1976). Usually, five dorsal and often more than five lateral pairs, although it can also present inequality in the number of scales on both sides; the anterior lateral pair is in contact with the pre-central scales. The plastron has four inframarginal scales and each has a pore (Márquez et al. 1976; Frazier 1983). On the anterior edge of each fin there are one or two nails. The head is medium, subtriangular and has two pairs of prefrontal scales and an unsealed corneal beak with alveolar ridge (Márquez 1990). The coloration of the carapace of adults is olive gray or yellowish, while the plastron is cream to greenish-gray with dark spots on the ends of the fins. (Márquez 1990). The young are dark gray to black in color and have an average length of 5 cm. The average weight reached by an adult is 38 kg.

In the only published study on the growth of this species, it indicates that they reach their sexual maturity around 13 years, with a maximum range of 24 years (Zug et al. 2006). This species is nocturnal nesting habits, although occasionally it does so during the day, especially on cloudy and windy days, and in the events of arribada. The nesting season of the Olive Ridley Turtle, in most of the Mexican Pacific occurs from July to

January, however, nesting can occur throughout the year. Spawning two to three times per season, in annual, bi-annual and triannual cycles (Márquez 1990).

4.3. Threats

For many years this species was subjected to an intensive fishery worldwide. In Mexico it was also affected on a smaller scale, but with devastating effects, by the bycatch and looting of eggs on its nesting beaches (Frazier 1983; Hinestroza and Páez 2000). Between the 1960s and 1970s, there are reports of catches of between 75,000 and 350,000 individuals per year in Mexico (Peñaflores et al. 1990) This fishery based on the Olive Ridley Turtle represented a catch volume close to 90% of total national production (Márquez et al. 1976). Its exploitation lasted until the end of the 1980s when it was declared, by agreement, the total and permanent ban on the capture of sea turtles in Mexico (Márquez. 1990).

4.3.1. Nesting sites

In Mexico, the Olive Ridley Turtle was the most important marine quelonido for fishing activity, because within the volume of capture it represented 90% of the total national production (Márquez et al. 1976). Its exploitation skyrocketed in the sixties and lasted until the early 1990s, when the total and permanent ban was declared for all species of sea turtles. Overexploitation, due to the interest in the consumption of their meat and eggs, remains a latent threat to the populations of all species of sea turtles today (TRAFFIC, 2002). Despite strict rules prohibiting their hunting and consumption, in many parts of the country the illegal sale of meat and the looting of nests for their local trade are still reported.

4.3.2. Marine areas

The biggest threat to juvenile and adult sea turtle populations globally is that posed bycatch. A large number of sea turtles are caught in various types of nets and hooked on longline hooks during activities aimed at other species. In most cases the result is the death of turtles caused by drowning by being forced to stay underwater longer than they can bear. In addition to this, there are also problems related to hook intake and obstruction of the respiratory tract (Gulko and Eckert 2004; Finkbeiner et al. 2011). As one of the efforts made to decrease the mortality of sea turtles due to interactions with the fishing industry, the US authorities regulated the use of turtle excluder devices (DET) since 1987, but their application was sporadic for several years, until in May 1991 they began to use it regularly (National Marine Fisheries Service and U. S. Fish and Wildlife Service 1998); in Mexico the use of DET was mandatory in shrimp trawlers from April 1993. In 1995, as in the state of Texas, the capture of shrimp by trawling was prohibited in Mexican waters in the periods from May 15 to July 15. These regulations in both countries have allowed the reduction of turtle bycatch.

4.4. Conservation

For the protection of sea turtles, the Government of Mexico has issued and monitored compliance with various legal regulations such as laws, decrees and agreements that protect the species that habit the national territory. This set of laws includes creation of natural protected areas (ANP) for the conservation of species, as well as the elaboration of regulations involving sea turtles.

4.5. Research

According to the Program of Action for the Conservation of the Olive Ridley turtle, *Lepidochelys olivacea*,(SEMARNAT 2018) a series of research and monitoring actions have been proposed in the population of Olive Ridley Turtle in Mexico with the aim of promoting and conducting research on the biology and ecology of the Olive Ridley Turtle and its habitat, as well as the risks faced by its populations in Mexico, and that these support the definition and structuring of specific actions for their protection, management, conservation and recovery.

a) Carry out studies on ecology and genetics of populations of the species to determine management units for conservation.

b) Generate and describe maps of the main threats and risks that affect the populations of the Olive Ridley Turtle.

c) Perform a comparative historical evaluation of the socio-environmental context of the perception of management and appreciation of the Olive Ridley Turtle in Mexico.

d) Identify and evaluate the impacts of tourism on the species to improve conservation programs.

e) Evaluate the health status of the populations of the specie

f) Study the movement of Olive Ridley Turtle through satellite tracking, metal and electronic markings.

g) Carry out studies in the areas of feeding, rest and reproduction to determine the degree of contamination by hydrocarbons and pesticides that affect the species.

In the case of biological monitoring actions of the population, the following actions have been established:

a) Monitor reproductive parameters of the nesting population of Olive Ridley Turtle.

b) Maintain the monitoring of the survival percentages of offspring differentiating the management technique of the nest of the Olive Ridley Turtle.

c) Establish a monitoring program for incubation temperature, physicochemical conditions of the sand and beach climate.

d) Annually analyze information on the demographic trend of the nesting population of Olive Ridley Turtle and risk factors.

e) Establish a monitoring program for males in breeding areas of Olive Ridley Turtle.

f) Monitor the fate of the nests to detect problems such as predation, looting, erosion or accretion on the index beaches.

g) Establish and consolidate biological monitoring programs in the main nesting beaches of Olive Ridley Turtle, with emphasis on beaches of arribazones, as well as those that are not yet subject to systematic monitoring.

h) Consolidate the systematic monitoring of predation by beetles and other invertebrates in Escobilla beach, and implement them in the other beaches of arribada.

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Table 1. Biological and conservation information about sea turtle Regional Management Units in Mexico.

RMU	Pacífico Oriental									
	Cm	**Ref #**	**Dc**	**Re f #**	**Lo**	**Ref #**	**Cc**	**Ref #**	**Ei**	**Ref #**
Ocurrencias										
Sitios de Anidación	Y	1	Y	1	Y	1,2	n/a		Y	36, 37
Sitios de Forrajeo Pelágicos	JA	1,2	n/a		A	1,51,55	JA	1	J	1
Sitios de Forrajeo Bénticos	JA	1,2	n/a		A	1,55	JA	1	J	1
Datos biológicos de importancia										
Nidos/por año: promedio actual (rango de años)							n/a		94 (2010-2014)	36,37
Nidos/por año: orden de magnitud actual							n/a			
Número de sitios con abundancia de anidación (>20 nidos/por año Y >10 nidos/km por año)	3	1,12	13	1	3	1, 12, 23	n/a		3	36,37
Número de sitios con menor anidación (<20 nidos/por año ó <10 nidos/km por año)			131	1			n/a			
Nidos/por año en sitios de abundancia: promedo actual (rango de años)							n/a			
Nidos/por año en sitios con menor anidación: promedio actual (rango de años)							n/a			
Largo total de sitios de anidación (km)			2226.2	1			n/a			
Hembras anidantes / por año	3500 (2011)#						n/a			
Nidos / temporada de anidación (N)							n/a			
Intervalo de remigración de hembras(años) (N)	3 años	1	2-3 años	1	1-2 años	23	2-3 años	1	3.5 años	1
Radio sexual: Neonatos (hembras / Total) (N)							n/a			
Radio sexual: Inmaduras (hembra / Total) (N)							n/a			
Radio sexual: Adulta (hembra / Total) (N)							n/a			
Min medidas adultos, LCC (cm)	85.7 LCC	1,	143 LCC	1,	60-73 LCC	1,	95-110 LCC	1	92.9- 94.4 LCC	1
Edad de madurez (yrs)	24 años	1,	13-14 años	1	13 años (10-18)^	1,	25-30 años	1		
Tamaño del nidos (n eggs) (N)	69.3	1,	64	1	110.6	23	110		150- 200	1
Éxito de eclosión (neonatos/huevos) (N)	70.6% Y 88.2% *		57%	1			n/a		75% - 85%	1
Nesting success (Nidos/ huellas totales) (N)							n/a			
Tendencias										
Tendencias actuales (últimos 20 años) en los sitios de anidación (rango de años)							n/a			

Tendencias actuales (últimos 20 años) en los sitios de forrajeo (rango de años)							43,226 (2015)"	24		
Mayor abundancia documentada: nido/año (rango de años)						58	n/a			
Estudios Publicados										
Tasas de crecmiento	Y	1,21			N		Y	16		
Genética					Y	1,27,34				
Stocks definidos por marcadores genéticos					N		Y	15, 41		
Rastreo remoto (satelital u otro)	Y	60	Y	59	Y	1,50,61			Y	37
Tasas de sobrevivencia	Y	28,33			Y	1,33,35	Y	13,33		
Dinámica de la población					Y	1		17		
Ecología de forrajeo (dieta/ isotopos)	Y	21,29,30, 32			y	32	Y	14,16, 24		
Captura- Marca -Recaptura	Y	12, 19, 20,21,31			Y	1, 23				
Amenazas										
Bycatch: presencia a menor escala / pesca artesanal?	Y (PT, SN,FP, PLL, PN)	1, 12	Y (PLL, SN, FP)	1	Y ()	1,52,53,54,57	Y (PLL, PN, DLL)	1, 24,42, 43	Y (PLL, PN, DLL)	1,44
Bycatch: presencia de pesca industria?	Y (PLL, DLL, PN)	1, 12	Y (PLL, PT, PN, SN, FP)	1	Y ()	1,52,53,54,57	Y (PLL, PT, MT,FP, ST)	1,24,42	Y (PLL, PT, MT,FP, ST)	1,44
Bycatch: cuantificada?	N		N		N		y	24,42	N	
Take. Mortalidad intencionada/ Explotación de tortugas	Y	1	Y	1	Y	1,12,52,53,54,57	Y	1,43	N	
Take. Saqueo de huevos	Y	1,12	Y	1	Y	1	n/a		N	
Desarrollo costero. Degradación del hábitat de anidación	Y	22	N		Y	12	n/a		Y	1,45
Desarrollo costero. Contaminación lumínica	Y	12	N		Y	12	n/a		Y	1,48
Desarrollo costero. Golpes de botes	Y	12			Y	12	Y	1, 24,42	Y	1
Depredación de huevos	Y	1			Y	12	n/a		N	
Contaminación (debris, química)	Y	49	Y	49	Y	49	Y	1, 24,42, 49	Y	49
Patógenos	N				N		Y	24	N	
Cambio Climático	Y	12			Y	12	n/a		Y	1,45,47
Degradación del hábitat de forrajeo	Y	12,22			N		Y	1, 24,42	Y	1
Otros	N				N		n/a		Y	1
Proyectos a largo plazo										
Monitoreo en sitios de anidación	Y	1	Y	1	Y	1	n/a		Y	36,37
Número de sitios de anidación prioritarios	3	1, 12, 22	3	1	3	1	n/a			

Monitoreo en sitios de forrajeo	Y	1, 22	N		N		Y	1,22, 24	N	
Conservación										
Protección bajo la ley nacional	Y	1,22	Y	1	Y	1	Y	1	Y	1,46
Número de sitios de anidacieon protejidos (preservación de hábitat)							n/a			
Número de áreas marinas con mitigación de amenazas										
Proyectos de conservación a largo plazo (número)										
Protección de nidos In- Situ (ej. jaulas)	N				Y		n/a		Y	1
Viveros	Y		Y	62	Y		n/a		Y	1
Head-starting	N		N		N		N		N	
By-catch: Modificación en los aparejos de pesca (ej, DET, canzuelos circulares)	Y! (TED)	1,22	Y (TED)	1	Y (TED)	1,56	Y (TED)	1, 24	Y	1
By-catch: buenas prácticas abordo	Y!	22					Y	24	Y	1
By-catch: vedas/reducción	Y	1, 12,22, 24	Y	1,1 2	Y	1,12	Y	1, 24	Y	1
Otros	Y	22					n/a			

* 70.6% de éxito de eclosión en nidos protegidos en vivero y 88.2% de éxito de eclosión en nidos naturales de Cm o Ca.

^ madurez sexual en promedio 13 años con un rango entre 10-18 de Cc.

! Monitoreos en áreas de alimentación

3500 hembras anidadoras solo en la playa de Colola, Michoacán para Ca o Cm.

" 2015 se hizo la primera estimación de Cc en el Golfo de Ulloa (Sitio de alimnetación)

Table 2. Sea turtle nesting beaches in Mexico.

Especie / RMU	Index site	Nidos/año: promedio actual (rango de años)	Límite Occidental		Límite Oriental		Punto Central		Largo (km)	% Monitoreado	# Referencia	Nivel de monitoreo (1-2)
Departamento			Long	Lat	Long	Lat	Long	Lat				
Playa de anidación												
Cm EPO												
JALISCO												
Chalacatepec	N	4178 (2012)	105° 17' 29"	19° 43' 8"	105° 12' 3"	19° 37' 21"	105°40'46.33"	19°40'46.33"	12		25,26	
Majahuas	N		105° 22' 6"	19° 50' 53"	105° 19' 0"	19° 47' 8"	105°22'17.77"	19°50'14.68"	10		25	
Playón de Mismaloya	N		105° 32' 58"	20° 5' 46"	105° 27' 5"	19° 56' 50"	105°29'37.43"	19°59'56.64"	19		25	
Teopa	N		105° 14' 9"	19° 25' 51"	105° 1' 51"	19° 23' 48"			7		25	
La Gloria	N		105° 27' 5"	19° 56' 50"	105° 22' 6"	19° 50' 53"	105°13'58.16"	20°37'50.68"	15		25	
COLIMA												
Isla Clarión	N						114° 43′ 19″	18° 21′ 32″				
Isla Socorro	N						110°59′0″	18°48′0″				
MICHOACÁN												
Colola	Y	119,150 (2008-2015)	103° 25' 52.55"	18° 18' 40.04"	103° 24' 34.53"	18° 17' 33.78"	103° 25' 50"	18° 18' 17"	4.80	100.0	1,5	2
Maruata	Y	1000 ±1500 (2015)	103° 21' 14.42"	18° 16' 05.15"	103° 19' 34.66	18° 15' 55.52"	103° 20' 35"	18° 16' 07"	2.40	100.0	1,6	2
Motín del Oro	Y		103° 28' 26.34"	18° 19' 39"	103° 27' 03.51"	18° 18' 44.39"	103° 27' 43.85"	18° 19' 03.13"	2.67	100.0	12	2
Paso de Noria	Y		103°18'42.63"	18°15'43.4"	103°17'55.22"	18°15'20.39"	103°18'15.89"	18°15'31.59"	1.57		8	
Playa azul	N		102°22'33.33"	17°59'11.16"	102°19'37.01"	17°58'24.66"	102°20'59.56"	17°58'49.34"	5.4		12	2
Caleta de campos	N		102°45'09.58"	18°04'21.90"	102°44'41.97"	18°04'23.69"	102°44' 54.95"	18°04'28.91"	1.16		12	2
La placita	N		103°36'25.55"	18°31'48.71"	103°35'58.56"	18°31'23.42"	103°36'06.95"	18°31'31.13"	1.10		12	2
Boca de Apiza	N		103°42'11.29"	18°39'19.64"	103°44'06.43"	18°40'59.99"	103°4'24.08"	18°41'19.13"	4.57		12	2
Playa la llorona	N		103°30'09.70"	18°20'25.63"	103°29'31.48	18°19'47.44"	103° 29'49.04"	18°20'16.63"	1.89		12	2

Playa la manzanillera	N		103°30'47.30"	18°21'32.91"	103°30'50.05"	18°21'11.81"	103°30'45.18"	18°21'22.31"	0.72		12	2
Faro de Bucerías	N		103°30'38.08"	18°20'48.36"	103°30'43.84"	18°21'06.08"	103°30'36.15"	18.20'58.41"	0.68		12	2
Barra de Pichi	N		102°20'35.29"	17°58'41.70"	102°19'17.54"	17°58'20.82"	102°19'58.32"'	17°58'18"	2.37		12	2
Barra de Tigre	N		102°21'40.32"	17°59'21.66"	102°21'40.32"	17° 58'59.59"	102°22'19.69"	17°59'07.75"	2.65		12	2
San Juan de Alima	N						103°40'28.28"	18.34'58.34"			12	2
Las calabazas	N		102°25'35.99"	18°00'0.533"	102°24'06.86"	17°59'37.26"	102°24'53.04"	18°00'01.81"	2.78		23	2
Playa Ximapa	N		103°27'59.78"	18°19'10.78"	103°26'48.76"	18°18'39.61"	103°27'16.81"	18°18'50.68"	2.27		12	2
Chuquiapan	N		102°36'42.88"	18°02'54.75"	102°36'25.37"	18°02'53.29"	102°36'35.65"	18°02'55.46"	0.54		12	2
OAXACA												
Morro Ayuta			95°52'54.52"	15°50'58.21"	95°51'39.87"	15°51'20.41"	95°52'20.08"	15°51'13.59"	2.47		25	
Dc EPO												
BAJA CALIFORNIA												
Agua Blanca	N		110° 35' 31"	23° 42' 01"	110° 16' 27"	23° 29' 34"	110° 23' 26"	23° 36' 55"	40.0	100.0	1,3	2
Cabo Pulmo	N		109°28'03".90	23°30'00"	109°23'00"	23°22'30"	109°25'53".61	23°22'30"	2.72		12,23	2
JALISCO												
Chalacatepec			105°15'45.64"	19°40'47.51"	105°13'28.20"	19°38'58.87"	105°14'35.07"	19°39'56.95"	5.16		25	
Playón de Mismaloya			105°29'45.34"	19°59'52.65"	105°29'39.95"	19°59'44.15"	105°29'42.88"	19°59'48.67"	0.28		25	
Cuitzmala			105°01'10.13"	19°22'50.79"	105°01'10.13"	19°22'50.97"	105° 00'24.08"	19°22'17.24"	3.40		25	
COLIMA												
Puerta del Mar			104°18'52.41"	19°05'23.97"	104°18'12.10"	19°03'43.56"	104°18'20.77"	19°04'38.00"	3.42		25	
Boca de Apiza			103°44'58.52"	18°42'06.09"	103°44'19.23"	18°41'05.48"	103°44'34.43"	18°41'36.23"	2.21		25	
Cuyutlán			104°04'34.14"	18°55'13.78"	104°03'28.59"	18°54'34.04"	104°04'02.70"	18°54'54.19"	2.28		25	
MICHOACÁN												
Mexiquillo	Y		102° 58' 25"	18°10' 25"	102° 48' 31"	18° 05' 34"	102° 55' 77"	18° 05' 34"	18.0		1,3,4	2
Colola			103° 25' 52.55"	18° 18' 40.04"	103° 24' 34.53"	18° 17' 33.78"	103° 25' 50"	18° 18' 17"	4.80		25	
Maruata			103° 21' 14.42"	18° 16' 05.15"	103° 19' 34.66	18° 15' 55.52"	103° 20' 35"	18° 16' 07"	2.40		25	
GUERRERO												
Tierra Colorada	Y		98° 43' 40"	16° 30'	98° 34' 05"	16° 19'			26.0		1,3	2

				03"		36"						
San Valentín	N		101° 20' 23"	17° 28' 42"	101° 14' 09"	17° 26' 17"	101°19'56.82"	17°19'56.82"	21.0		1,3	2
Piedra de Tlacoyunque	N		101° 03' 0"	17° 15' 59"	100° 39' 43"	17° 08' 15"			44.0		1,3	2
Playa Ventura	N		98° 58' 12"	16° 33' 32"	98° 55' 14"	16° 32' 25"	98°54'49.30"	16°32'22.30"	6.0		1,3	2
OAXACA												
Cahuaitán	Y		98° 32' 26"	16° 18' 42"	98° 26' 59"	16° 16' 47"	98°29'55.41"	16°17'53.71"	12.0		1,3	2
Barra de la Cruz	Y		95° 57' 59"	15° 49' 19"	95° 53' 28"	15° 50' 36"	95°57'55.59"	15°49'28.96"	8.0		1,3	2
La tuza	N		97° 54' 34"	16° 03' 57"	97° 47' 20"	15° 59' 12"	97°51'41.47"	16°01'51.22"	16.0		1,3	2
San Juan Chacahua	N		97° 46' 41"	15° 58' 45"	97° 40' 41"	15° 57' 50"			11.0		1,3	2
Cerro Hermoso	N		97° 40' 37"	15° 57' 52	97° 34' 05"	15° 57' 55"	97°32'08.54"	15°58'10.73"	12.0		1,3	2
Palmarito	N										25	
Morro Ayuta							74°0'21.38"	40°42'46.02			25	
L.o. EPO												
Arribadas												
MICHOACÁN												
Playa Ixtapilla	Y	204,737.5 (2008-2015)	n/a	n/a	n/a	n/a	103° 31' 54"	18° 25' 04"	600m	100%	1,12	2
OAXACA												
Santuario playa de Escobilla	Y	1,183,750 (2008-2015)					96°44'45.78"	15°43'36.49"	25.0		1,12	
Playa de Morro Ayuta							74°0'21.38"	40°42'46.02			1,12	
Solitaria												
SINALOA												
Isala Quevedo	N	162 (2015)					107°21'34.87"	24°12'25.23"	26.0		1	2
Isla Santa María	N	99 (2015)					109°15'57.24"	25°38'25.93"	25.0		1	2
Las arenitas	N	199 (2015)					107°33'39.79"	24°21'01.80"	59.0		1	2
Ceuta	N	679 (2015)					106°58'34.13"	23°55'10.50"	40.0		1	2
Celestino Gasca	N	255 (2015)					106°53'01.26"	23°49'08.62"	35.0		1	2
Barras de Piaxtla	N	1781 (2015)^					106°48'05.04"	23°39'48.31"	5.0		1	2
Pozole	N	1781 (2015)^					106°43'24.08"	23°35'30.27"	8.0		1	2
Toyhua	N	1781 (2015)^					106°42'22.4	23°34'44.5	12.0		1	2

							7"	8"				
El verde	N	2666 (2015)					106°30'48.1 1"	23°22'11.3 6"	28.0		1	2
Playas urbanas de Mazatlán	N	1678 (2015)							21.0		1	2
Isla de la Piedra	N	4553 (2015)					106°24'29.0 9"	23°11'36.0 2"	17.0		1	2
Caimero	N	4305 (2015)							41.0		1	2
Chametla	N	247 (2015)							9.0		1	2
Playa las Cabras	N	841 (2015)					105°51'59.6 6"	22°42'18.7 0"	12.0		1	2
Isla del Bosque	N	45 (2015)					105°52'31.5 7"	22.42'48.8 7"	6.0		1	2
La Guásima							106°07'22.2 0"	22°56'11.0 8"			25	
Teacapan	N	44 (2015)							13.0		1	2
NAYARIT												
Playa de Chila							105°13'14.7 5"	21°15'22.8 5"			18	2
Playa de Platanitos							105°14'26.1 9"	21°21'06.3 3"			18	2
San Francisco							105°24'51.7 4"	20°54'16.8 4"			18	2
El Naranjo							105°13'47.6 0"	21°05'03.4 7"			18	2
Nuevo Vallarta	N	5039 ±1705 (2005-2008)					105°17'51.9 0"	20°41'43.0 7"			18	2
Bahia de Badera	N	3742 ± 904									18	2
JALISCO												
Boca de Tomates	N	10.121 (2016) #					105°16'26.2 9"	20°40'13.2 9"			18	2
Puerto Vallarta	N	10.121 (2016) #									18	2
Mayto	N	10.121 (2016) #					105°34'57.6 8"	20°15'09.2 7"			18	2
Teopa			105° 14' 9"	19° 25' 51"	105° 1' 51"	19° 23' 48"			7		25	
Mismaloya							105°29'37.4 3"	19°59'56.6 4"			12	2
Chalacatepec							105°40'46.3 3"	19°40'46.3 3"			25	
Cuitzmala							105°17'30.6 6"	20°31'56.7 6"			25	
La Gloria							105°13'58.1 6"	20°37'50.6 8"			25	
Majahuas							105°22'17.7 7"	19°50'14.6 8"			25	
COLIMA												
Boca de Apiza							103°4'24.08"	18°41'19.1			25	

								3"				
MICHOACÁN												
Colola	N	1,046 (1991-2002)	103° 25' 52.55"	18° 18' 40.04"	103° 24' 34.53"	18° 17' 33.78"	103° 25' 50"	18° 18' 17"	4.8	100.0	1,5,12	2
Maruata			103° 21' 14.42"	18° 16' 05.15"	103° 19' 34.66	18° 15' 55.52"	103° 20' 35"	18° 16' 07"	2.4	100.0	1,6,12	2
Mexiquillo							102° 55' 77"	18° 05' 34"			25	
GUERRERO												
Piedra de Tlacoyunque											12	2
La Gloria							99°45'00.02"	16°44'19.07"			12	2
Playa Ventura							98°54'49.30"	16°32'22.30"			25	
Pico del Monte											25	
Tierra Colorada											25	
Playa Encantada							99°38'03.08"	16°41'23.45"			25	
Estero Colorado											25	
OAXACA												
San Juan Chacuaha											12	2
Barra de la Cruz							95°57'55.59"	15°49'28.96"			25	
CHIAPAS												
Playa puerto Arista	N						93°48'35.67"	15°55'57.76"			25	
E.i. EPO												
SINALOA												
Guasave			108°32'00.09"	25°17'52.25"	108°23'40.84"	25°11'31.49"	108°27'07.91"	25°15'30.60"	18.73		1	
NAYARIT												
Punta de Mita		41 (2010-2014)	105°31'26.38"	20°46'05.05"	105°28'55.95"	20°45'20.99"	105°28'55.95"	20°45'20.99"	6.1		36,37	
Bahia de Jaltemba			105°17'33.10"	21°01'30.97"	105°16'59.15"	21°01'40.58"	105°17'16.67"	21°01'32.74"	1.5		1	
San Blas		2 (2010-2014)					105°17'3.48"	21°32'28.5"	7		36,37	
Platanitos		15 (2010-2014)					105°14'26.19"	21°21'06.33"			36,37	
Chila							105°13'14.75"	21°15'22.85"			36,37	
JALISCO												
Costa Careyes		36 (2010-2014)					104°46'19.9194"	19°16'0.12"			36,37	
Playa Teopa			105° 14' 9"	19° 25'	105° 1' 51"	19° 23'			7		63	

				51"		48"						
Tehuamixtle							105°35'13.27"	20°11'54.74"			1	
Mayto							105°34'57.68"	20°15'09.27"			1	
Playa Cuitzmala			105°01'10.13"	19°22'50.79"	105°01'10.13"	19°22'50.97"	105° 00'24.08"	19°22'17.24"	3.40		63	
COLIMA												
Isla Revillagigedo							112°45'50"	18°49'17"			63	
Isla Socorro							110°59′0″	18°48′0″			63	

10.121 (2016) total de nidos de las tres playas (Boca de tomates, Puerto Vallarta y Mayto)
^1781 (2015) total de nidos en las tres playas (meseta de Cacaxtla)

Table 3. International conventions protecting sea turtles and signed by Mexico.

Convenciones Internacionales	Firmados	Convenio Vinculante	Especies	Acciones de conservación	Relevancia para las tortugas marinas
Apendice 1 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).	Y	Y	ALL	El comercio se encuentra sujeto a reglamentación estricta.	Se prohibe el comercio de cualquier especie de tortuga marina, y se regula mediante una serie de acciones aplicadas con los diferentes países que forman parte del convenio.
Acuerdo de cooperación ambiental de America del Norte y Comisión para la Cooperación Ambiental (CCA) 1994.	Y		ALL		
Convención de las Naciones Unidas sobre el Derecho del Mar (UNCLOS), Montego Bay, 1982.	Y		ALL		
Memorándum de entendimiento, programa de coperación MexUs Golfo y MexUs Pacífico, 1992.	Y		ALL		
Convenio sobre Diversidad Biológica, 1993.	Y		ALL		
Código de Conducta para la pesca responsable, FAO, 1995.	Y		ALL		
Convención Interamericana para la Protección y Conservación de las Tortugas Marinas (CIT), 1999.	Y	Y	ALL	Brindar protección a las tortugas en territorio nacional	rectricion de actividades humanas, prohibido captura o comercio, ptotección del habitat.
Simposium internal de tortuga marina, 1998. Mazatlan, México.			ALL		
Simposium internal de tortuga marina, 2008. Loreto, México.			ALL		
Simposium internal de tortuga marina, 2012. Huatulco, México.			ALL		

Table 4. Projects and databases on sea turtles in Mexico.

NGO, ANP Y RPC	Primary species	Primary beaches	Long-term (>5 consecutive years)
Ayotzintli A.C.	*Lo*		Y
Los Grupos Ecologistas de Nayarit A.C	*Lo*	EL Naranjo	Y
Red Tortuguera A.C.	*Lo*	Mayto	Y
Sea Turtle Protection Program at Acuario Mazatlan	*Lo*	Mazatlán	Y
Tortugueros Las Playitas A.C.	*Cm*	Todos Santos	Y
Colola Capital mundial de la tortuga negra A.C.	*Cm*	Playa de Colola	Y
Santuario Playa Teopa, Jal.		Playa Teopa	Y
Santuario Playa Cuixmala A.C., Jal.		Playa Cixmala	Y
Grupo tortuguero el Conchal, Sinaloa	*Lo*	Isla Quevedo	Y
Grupo tortuguero de las Californias			Y
PN CABO Pulmo, BCS, Los Cabos.	*Cc*	Los Cabos	Y
RPC Lucenilla, Sin.		Lucenilla	Y
Santuario Playa Ceuta, Sin.		Playa Ceuta	Y
Playa Verde Camacho, Sin		Playa Verde Camacho	Y
RPC Playa Platanitos, Nay.		Playa Platanitos	Y
RCP Nuevo Vallarta, Nay.		Bahía de Banderas	Y
Santuario Playa de Mismaloya, Jal.		Playa Mismaloya	Y
RCP Playa Chalcatepec, Jal.		Playa Chalcatepec	Y
Playas Boca de Apiza, El Chupadero y El Tecuanillo, Col.		Boca de Apiza	Y
Santuario Playa Mexiquillo, Mich.		Mexiquillo	Y
Santuario Playa Tierra Colorada, Gro.		Tierra Colorada	Y
RPC Playa Cahuitán, Oax.			Y
Santuario Playa de la Bahía de Chacahua, Oax.		Chacahua	Y
Santuario Playa de Escobilla, Oax.		Escobilla	Y

RPC Barra de la Cruz y Playa Grande, Oax.		Barra de la Cruz	Y
RPC Morro Ayuta, Oax.		Morro Ayuta	Y
Santuario Playa de Puerto Arista, Chiapas.		Puerto Arista	Y
Kutzari, Asociación para el Estudio y Conservacion de las Tortugas Marinas A.C.	Dc		Y
ASUPMATOMA A.C.	Dc		Y
Red de Humedales de la Costa de Oxaca	Dc		Y
Fondo Oaxaqueño para la Consevación de la Naturaleza A.C.	Lo		Y
Costa Salvaje A.C.	Lo		Y
Piedra de Tlacoyunque, Gro.	Lo		Y
Agua Blanca B.C.S.	Dc		Y
FEEDING GROUNDS			
RB Bahía de los Angeles y El Barril, BC.		Bahía de los Angeles	Y
RB El Vizcaíno, BC.		Vizcíno	Y
PN Bahía de Loreto		Loreto	Y
La Paz, BCS		La Paz	Y
RB Islas del Golfo, Sonora y Sinaloa			Y

Guatemala

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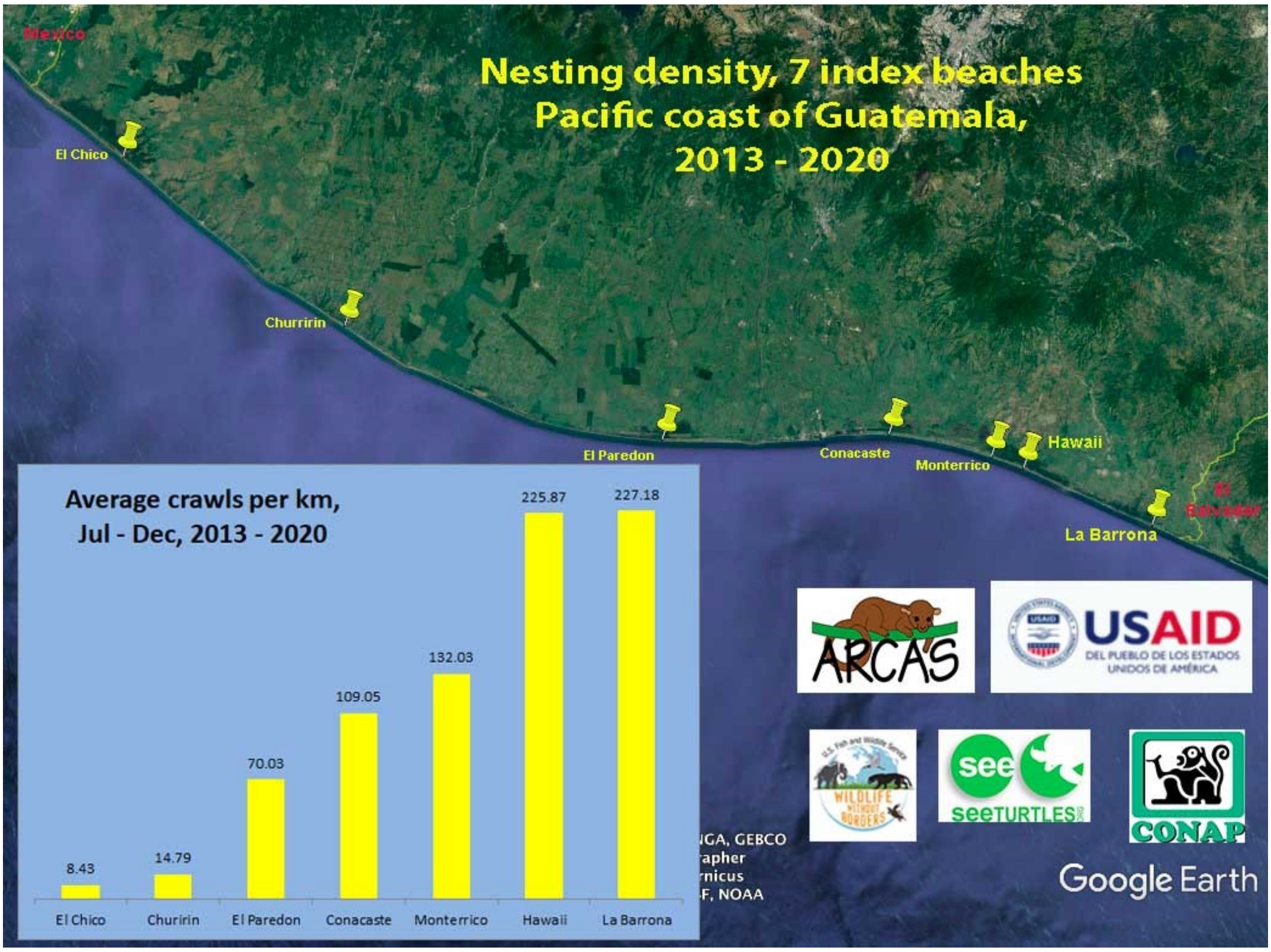
1. RMU: Olive ridley (*Lepidochelys olicacea*) – Eastern Pacific

1.1. Distribution, abundance, trends

Nearly all sea turtle nests laid on the 254km Pacific coast of Guatemala are olive ridleys. Guatemalan olive ridleys are solitary nesters, with no hotspots, and exhibiting none of the arribada mass-nesting behavior they are known for at other sites. Nonetheless, it is an important rookery and, extrapolating from ARCAS crawl count surveys conducted on 7 indexes beaches, we estimate that in 2020, 19,813 nests were laid on the Pacific coast. The crawl count surveys also find that nesting density steady increases from west to east.



1.1.1. Nesting sites

The Guatemalan Pacific coast is comprised of straight, uniform, high energy black sand beaches with no coves or rock formations. Though nesting density increases from west to east, there are no discreet beaches where nesting appears to be heavier than others. Since 2003, ARCAS has been conducting crawl count surveys in the Hawaii area, and since 2013, on 6 additional index beaches. (See map above).

1.1.2. Marine areas

There is no information available about important foraging or migratory areas in the Pacific ocean.

1.2. Other biological data

The overall population trend of the olive ridley on the Pacific coast of Guatemala is increasing. ARCAS's nesting crawl count program has documented that the nesting in the 8kms of monitoring at the Hawaii site has increased from 906 crawls in 2003 to 1,422 crawls in 2019, although 2018 and 2019 have seen a worrisome decline. This trend has been confirmed in crawl counts carried out on the other 6 index beaches of El Chico, Churirin, El Paredón, Conacaste, Monterrico, and La Barrona. (Muccio, 2020).

1.3. Threats

The principal threats to the sea turtle in Guatemala are: 1) Harvesting/poaching of eggs; 2) Incidental capture and death of adults by commercial fishing operations (usually shrimp trawlers); 3) Marine pollution, especially chemicals and plastics; and, 4) Touristic, urban or industrial development of nesting habitat;

Virtually all nests laid on Guatemalan shores are harvested; it is very rare that a nest is laid without being detected by an egg collector. It is such a rare event that locals or tourists who find emerging hatchlings are startled and bring them to hatcheries for advice on what to do to "help" them.

During the peak nesting weeks in August and September, the beach resembles a popular beachside boardwalk with egg collectors every 50 meters scanning the surf for emerging turtles. The emergence of a turtle often results in footraces and even altercations to "claim" the turtle. This high level of human predation has apparently been going on for at least 45 years as Ramboux ('82) reported that in the areas of El Chapeton and Las Lisas "not one hatchling has hatched naturally for the last eight years."

Plastic pollution is omnipresent, and there are occasional strandings of turtles ill after having ingested plastic bags.

A 2018 NOAA study found that an algae bloom caused by agricultural runoff caused a mass stranding that occurred in El Salvador, but which also affected the southeast sector of the Guatemalan coast.

There is no reported consumption of turtle meat and there has been no known usage of other turtle derivatives such as leather or shell. However, there are rumors that turtles are caught at sea and used as bait for shark fishing.

Apart from the Puerto Quetzal/Puerto San Jose area, the tourist industry has developed in a relatively low-key fashion, primarily with the construction of individual vacation homes and hotels, and none of the large scale development of an area such as Cancun. However, given the demographic growth of the area and the lack of regulation, beach-lighting will almost certainly become a more serious problem in the future.

1.3.2. Marine areas

Industrial shrimp trawling is the principal open ocean threat to the sea turtles of Guatemala and strandings have been seen to coincide with trawling off shore. Shrimp trawlers are required to use turtle excluder devices, but enforcement is lax.

ARCAS responded to and documented mass stranding events in 2011 and 2013, and sporatic strandings are a regular feature of any nesting season. In 2019, an estimated 392 olive ridleys stranded along the Guatemalan Pacific coast. (Muccio, 2020)

1.4. Conservation

Sea turtle conservation efforts in Guatemala rely almost exclusively on a conservation quota system initiated in the 80s whereby local egg collectors are allowed to harvest olive ridley nests as long as they donate 20% of each nest to a registered hatchery. Only olive ridleys eggs are allowed to be harvested; all other species are prohibited.

Over the years, the number of hatcheries operating in Guatemala have varied from 16 to 35, depending on the resources and sponsors available. The management and sponsorship of these varies, being actors in this process the National Council of Protected Areas (CONAP), NGOs, educational institutions, members of the private sector and government agencies.

Guatemalan hatcheries are fundamentally community and private sector-based since the central government lacks the resources to enforce the conservation quota and most of the eggs collected are the product of voluntary conservation quotas delivered by collectors or "parlameros". However, in recent years various sponsor-a-nest schemes have greatly increased the number of eggs collected and incubated on a national scale. Most hatcheries are managed by local residents who, in many cases, lack the technical capacity and financial resources to carry out proper technical management and scientific research. Also, hatcheries can (and should) be focal points for a variety of environmental activities within the community, including environmental education, research, and eco-tourism, aspects covered only by the best-managed hatcheries.

1.5. Research

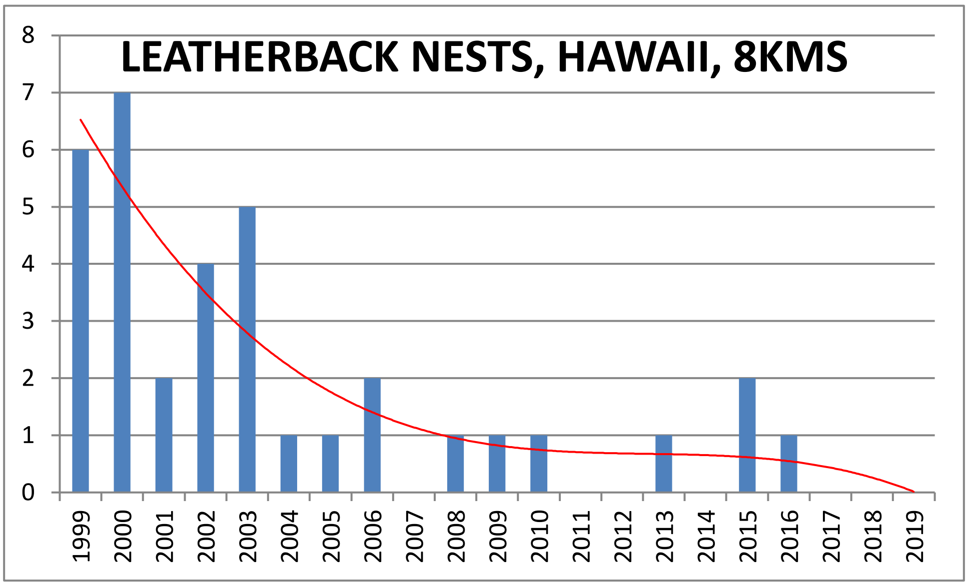
Initiated in 2003, the ARCAS sea turtle crawl count program and its annually-updated Situational Analysis is the only long-term dataset on the marine fauna of Guatemala and contributes to decision-making on conservation priorities, the establishment of MPAs and other policy decisions. It consists of daily crawl count patrols carried out

Research has been carried out by Guatemalan and overseas university and post graduate student in a variety of topics, many focusing on the viability of the conservation quota system, hatchery management (sex bias) and population surveys.

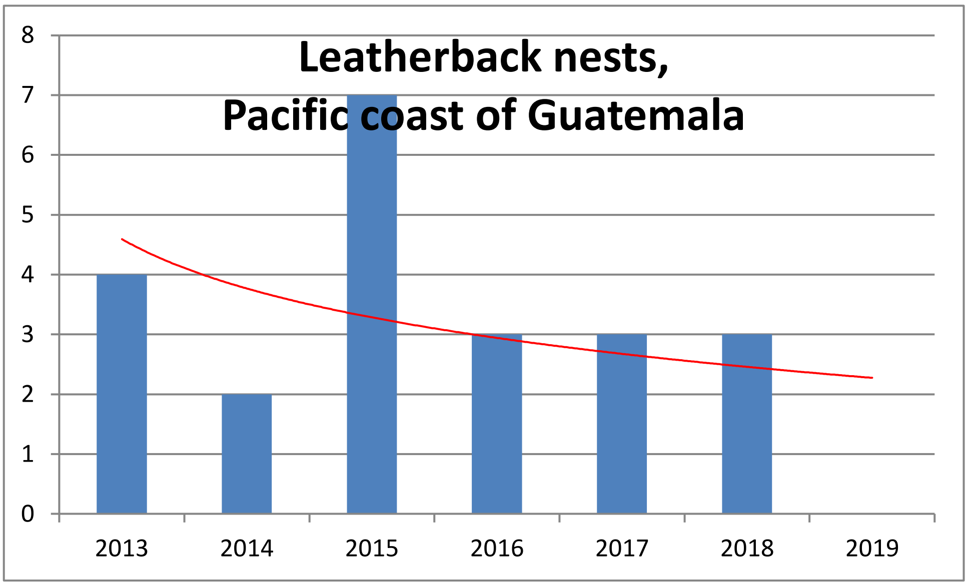
2. RMU: leatherback turtle (*Dermochelys coriacea*) – Eastern Pacific

2.1. Distribution, abundance, trends

In contrast to the olive ridley, nesting density of leatherbacks in Guatemala is declining. A reduction in nesting has been documented in the 8 km of beach monitored in Hawawii from 4-6 nests per year in 1999 - 2003, to 0 - 2 nests per year in recent years.



On a national scale, the nesting of the leatherback turtle remains scarce, with 0 - 6 nests per year reported along the Pacific coast of Guatemala. In 2018, three nests of this species were recorded, but unfortunately no eggs from these nests hatched. In 2019 no nests were reported.



2.1.1. Nesting sites

Nesting appears to be uniform, but, like the olive ridley, more frequent in the southeast sector.

2.1.2. Marine areas

2.2. Other biological data

In recent years, several leatherback nests have been lost; either poached or improperly handled before being delivered to a hatchery. Of the few nests that have been rescued and incubated in hatcheries, many have had hatching success rates of 0% to 20%. There is urgent need to carry out research on whether this low hatching success is due to infertile eggs or improper handling of eggs in hatcheries.

2.3. Threats

Although CONAP Resolution 3-17-2017 for the first time regulates the conservation quota system and explicitly prohibits the use of leatherback, green and hawksbill eggs, the eggs of these non-olivacea turtles are often poached and not turned in to hatcheries. Enforcement officials and egg collectors alike lack a full understanding of the Resolution and the urgent need to protect these species.

3. RMU: Green turtle (*Chelonia mydas*) – East Pacific

In the last five years, 0-4 Pacific green sea turtle nests have begun to be reported along the Pacific coast of Guatemala.

3.1. Distribution, abundance, trends

3.1.1. Nesting sites

Does not apply

3.1.2. Marine areas

Adult greens and a few hawksbills forage year-round in an inland mangrove waterway named Pozo del Nance. The Guatemalan NGO Protortugas has carried out research on this population of turtles.

https://www.facebook.com/photo?fbid=819644918089825&set=a.393159157405072

3.2. Threats

Although CONAP Resolution 3-17-2017 for the first time regulates the conservation quota system and explicitly prohibits the use of leatherback, green and hawksbill eggs, the eggs of these non-olivacea turtles are often poached and not turned in to hatcheries. Enforcement officials and egg collectors alike lack a full understanding of the Resolution and the urgent need to protect these species.

Greens have also been found stranded, presumably drowned in shrimp trawl nets.

4. RMU: Hawksbill turtle (*Eretmochelys imbricata*) – Eastern Pacific

4.1. Distribution, abundance, trends

ARCAS documented the first nesting of an adult hawksbill on the Pacific coast of Guatemala in 2019. (Muccio, et al, 2019).

4.2. Threats

4.2.1. Marine areas

Juvenil hawksbills are regularly caught incidentally by artisanal fishermen in coastal waters and mangrove waterways, but apart from an occasional individual in Pozo del Nance, adult hawksbills are not reported.

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Table 1. Biological and conservation information about sea turtle Regional Management Units in Guatemala.

RMU	L. olivacea EP	Ref #	D. coriacea EP	Ref #
Occurrence				
Nesting sites	Y	1,7	Y	1,7
Oceanic foraging areas	U		U	
Neritic foraging areas	Y	3	U	
Key biological data				
Nests/yr: recent average (range of years)	17860 (2013-2020)	PS	0-7(2013-2019)	PS
Nests/yr: recent order of magnitude				
Number of "major" sites (>20 nests/yr AND >10 nests/km yr)	N/R		N/R	
Number of "minor" sites (>20 nests/yr OR >10 nests/km yr)	N/R		N/R	
Nests/yr at "major" sites: recent average (range of years)	N/R		N/R	
Nests/yr at "minor" sites: recent average (range of years)	N/R		N/R	
Total length of nesting sites (km)	254	PS	254	PS
Nesting females / yr	U		0-1	PS
Nests / female season (N)	U		3-6	PS
Female remigration interval (yrs) (N)	U		N/R	
Sex ratio: Hatchlings (F / Tot) (N)	U		N/R	
Sex ratio: Immatures (F / Tot) (N)	U		N/R	
Sex ratio: Adults (F / Tot) (N)	U		U	
Min adult size, CCL or SCL (cm)	U		N/R	
Age at maturity (yrs)	U		U	
Clutch size (n eggs) (N)	92.66	PS	U	
Emergence success (hatchlings/egg) (N)	90-94	PS	0-40	PS

Nesting success (Nests/ Tot emergence tracks) (N)	90.34	PS	U	
Trends				
Recent trends (last 20 yrs) at nesting sites (range of years)	Increasing (2003-2020)	PS	Declining (1999-2019)	
Recent trends (last 20 yrs) at foraging grounds (range of years)	U		U	
Oldest documented abundance: nests/yr (range of years)	U		n/r	
Published studies				
Growth rates	U		U	
Genetics	U		U	
Stocks defined by genetic markers	U		U	
Remote tracking (satellite or other)	U		U	
Survival rates	U		U	
Population dynamics	U		U	
Foraging ecology	U		U	
Capture-Mark-Recapture	U		U	
Threats				
Bycatch: presence of small scale / artisanal fisheries?	Y (PLL, SN,)	PS	N	
Bycatch: presence of industrial fisheries?	Y (ST)	PS	U	
Bycatch: quantified?	N	PS	N	
Intentional killing of turtles	U		N	
Take. Illegal take of turtles	N		N	
Take. Permitted/legal take of turtles	N		N	
Take. Illegal take of eggs	Y	PS	Y	PS
Take. Permitted/legal take of eggs	Y	PS	N	

Coastal Development. Nesting habitat degradation	Y	PS	Y	
Coastal Development. Photopollution	Y	PS	Y	
Coastal Development. Boat strikes	U		U	
Egg predation	N	PS	N	
Pollution (debris, chemical)	U		U	
Pathogens	U		U	
Climate change	U		U	
Foraging habitat degradation	U		U	
Other	N		N	
Long-term projects (>5yrs)				
Monitoring at nesting sites (period: range of years)	Y (2003-ongoing)	Table 4, PS	Y (2003-ongoing)	Table 4, PS
Number of index nesting sites	7	Table 2	n/r	
Monitoring at foraging sites (period: range of years)	N		N	
Conservation				
Protection under national law	Y	5,2	Y	5,2
Number of protected nesting sites (habitat preservation) (% nests)	0	PS	0	PS
Number of Marine Areas with mitigation of threats	4	PS	4	PS
N of long-term conservation projects (period: range of years)	31 (1979 - present)	Table 4	31 (1979 - present)	Table 4
In-situ nest protection (eg cages)	N		N	
Hatcheries	31	PS	31	PS
Head-starting	N		N	
By-catch: fishing gear modifications (eg, TED, circle hooks)	Y	PS	Y	PS
By-catch: onboard best practices	N		N	
By-catch: spatio-temporal closures/reduction	N		N	
Other	Y (see text)	PS	N	

Table 2. Sea turtle nesting beaches in Guatemala.

RMU / Nesting beach name	Index site	Nests/yr: recent average (range of years)	Crawls/yr: recent average (range of years)	Western limit		Eastern limit		Length (km)	% Monitored (July - December)	Reference #	Monitoring Level (1-2)	Monitoring Protocol (A-F)
LO				Long	Lat	Long	Lat					
El Chico	Y		42.14 (2013-2020)	N 14° 25' 39.13"	W 92° 05' 09.72"	N 12° 23' 58.95"	W 92° 02' 56.68"	5	100	2		B
Churririn	Y		39.5 (2013-2020)	N 14° 07' 26.10"	W 91° 40' 11.25"	N 14° 06' 39.06"	W 91° 38' 55.86"	2.67	100	2		B
El Paredon	Y		399.14 (2013-2020)	N 13° 54' 59.13"	W 91° 05' 26.29"	N 13° 54' 51.91"	W 91° 02' 18.23"	5.7	100	2		B
Conacaste	Y		872.37 (2013-2020)	N 13° 55' 42.72"	W 90° 42' 05.14"	N 13° 55' 22.92"	W 90° 37' 40.06"	8	100	2		B
Monterrico	Y		893.87 (2013-2020)	N 13° 53' 53.83"	W 90° 30' 38.12"	N 13° 52' 44.19"	W 90° 27' 05.28"	6.77	100	2		B
Hawaii	Y		1438.29 (2003-2020)	N 13° 52' 44.19"	W 90° 27' 05.28"	N 13° 51' 16.00"	W 90° 23' 13.31"	7.47	100	2		B
La Barrona	Y		1756.12 (2013-2020)	N 13° 46' 26.80"	W 90° 07' 59.73"	N 13° 44' 44.38"	W 90° 07' 59.73"	7.73	100	2		B
DC												
Entire Guatemalan Pacific coast (254km)	N	3.75 (2013-2019)						254	0	2		
Hawaii	Y	1.8 (1999-2019)		N 13° 52' 44.19"	W 90° 27' 05.28"	N 13° 51' 16.00"	W 90° 23' 13.31"	7.47	100	2		
CM												
	N	0-4 (2016 - 2020)										
EI												
	N	First nest documented in 2018										

Table 3. International conventions protecting sea turtles and signed by Guatemala.

International Conventions	Signed	Binding	Compliance measured and reported	Species	Conservation actions	Relevance to sea turtles
IAC	Y	U	Reported sporatically, but not measured	Lo, Cm, Dc, Cc, Ei	Should elaborate a management plan for use of L.o. Eggs	

Table 4. Projects and databases on sea turtles in Guatemala.

#	RMU	Country	Region / Location	Project Name or descriptive title	Key words	Start date	End date	Leading organisation	Public/Private
T4.1	LO-EP	Guatemala	EP	Crawl count population monitoring and Situational Analysis of Sea Turtles in Guatemala	Crawl counts, hatchery data, stranding data	2003	ongoing	ARCAS	NGO

El Salvador

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1. RMU: Olive ridley turtle (*Lepidochelys olivacea*) – Eastern Pacific

1.1. Distribution, abundance, trends

1.1.1. Nesting sites

Olive ridleys are the most common species that occur in El Salvador, with a distribution that extends across more than 60 beaches along the entire 300 km coast of the country (Table 1).[1,2,16] Olive ridley nesting is solitary and typically occurs between August and November.[1,2] The absence of consistent, long-term tagging programs at these beaches hamper the ability to accurately estimate nesting female abundance. However, nest protection data collected during conservation projects at 36 beaches indicate there are four priority olive ridley nesting sites: Los Cóbanos (1255.0 nests/yr), San Diego (1381.3 nests/yr), Toluca (823.5 nests/yr), and Isla Tasajera (1036.0 nests/yr) (Fig. 1, Table 2).[16] It is important to note that these data may be influenced by the level of effort realized by each project, which can vary by beach size, dates of operation, and available funding. Given the inconsistent monitoring of olive ridley nesting beaches over time, it is difficult to identify any clear trends in nesting abundance. However, intensive sea turtle conservation efforts over the last decade, in which more than 10 million olive rildey hatchlings were released into the ocean,[16] will likely facilitate a short- to medium-term increase in nesting female abundance in El Salvador.

1.1.2. Marine areas

Olive ridleys are commonly observed in marine areas along the entire coast of El Salvador (Fig. 2), particularly during July–November when reproductively active males and females aggregate in large numbers in offshore waters near nesting beaches.[9] Local fishers have identified the offshore waters of El Salvador from 50 to 100 m of depth as areas important for olive ridleys, with some fishers claiming to have seen hundreds to thousands of olive ridleys in groups of 60 to 100 individuals during the nesting season.[9] The use of marine areas in El Salvador is further supported by the incidental capture of 17 individuals in surface longline fisheries during circle hook trials in May–December 2008.[8] Data are not available on in-water abundance and trends of olive ridleys in Salvadoran waters.

1.2. Other biological data

N/A

1.3. Threats

1.3.1. Nesting sites

Although intentional killing of olive ridleys on nesting beaches is rare, there are cases of nesting females being killed to extract eggs for human consumption. Take of eggs from nesting beaches, however, is ubiquitous.[2] Nearly 100% of all olive ridley eggs deposited on Salvadoran beaches are collected by local residents for either protection (legal) or human consumption (illegal); whether the collected eggs are protected or consumed often depends on if there is a conservation project that will purchase the eggs from the local collector.[25]

Coastal development is another pervasive threat facing olive ridleys in El Salvador. Most of the Salvadoran coast is heavily developed, which has resulted in extensive nesting habitat degradation and photopollution.[24] Vegetation has been cleared at many beaches, with coastal infrastructure (e.g., walls and houses) often located near the high tide line.[24]

1.3.2. Marine areas

Olive ridleys found adrift or stranded are a relatively common occurrence along the coast of El Salvador.[2,41] Assigning cause of mortality for sea turtles found adrift or stranded on a beach is challenging given the diverse array of human and natural threats operating in dynamic aquatic environments. However, interactions between olive ridleys and pelagic long lines and shrimp trawls have been documented in marine areas of El Salvador and appear to represent important threats to the species.[8,10,41]

A study on the incidental capture of sea turtles by an artisanal long-line fishery in El Salvador reported that of 4,443 hooks sampled, 11 olive ridleys were hooked and six were entangled, all of which were reportedly released alive.[8] This same study calculated the following incidental capture rate: 10 turtles/1000 J4-hooks, 4 turtles/1,000 C13-hooks, 1.2 turtles/1,000 C15-hooks, and 0.7 turtles/1,000 C14-hooks.[8]

There is also evidence of shrimp trawls interacting with olive ridleys in Salvadoran waters at depths of 10 to 80 m.[10] Despite the mandatory use of turtle excluder devices (TEDs) on all active shrimp trawls, local fishers have reported seeing trawls operating without TEDs or TEDs that had been sown closed.[41] Salvadoran law also prohibits shrimp trawls from operating within three nautical miles from shore, but violations commonly occur.[42]

Harmful algal blooms (HABs), or red tides, have been implicated in contributing to the mass mortality of hundreds of olive ridleys along the coast of El Salvador.[28] During a red tide event in 2013, high saxitoxin concentrations in samples taken from the organs of dead olive ridleys suggested intoxication from paralytic shellfish poisoning.[28] Red tide events appear to be increasing in frequency, which can further threaten olive ridleys in marine areas of El Salvador.

1.4. Conservation

The Salvadoran government has established a legal framework to provide sea turtles protection through the ratification of international agreements, such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on Biological Diversity (Table 3). National legislation recognizes and extends protection to sea turtles as endangered species and attempts to mitigate the incidental capture of sea turtles in fisheries. In 2009, the Salvadoran government prohibited the collection and sale of sea turtle products, including eggs, for purposes other than conservation.

High human density and acute poverty in coastal areas have made the protection of olive ridley nests in situ (i.e. original site of deposition on the beach) infeasible.[5] Nearly 100% of eggs deposited by olive ridleys are collected by local residents as a livelihood resource and are sold either legally to local NGOs for protection in hatcheries (flat rate

= $2.50 per dozen eggs) or illegally to local markets for human consumption (mean = $2.78 [$2.10–4.00] per dozen eggs).[43] By purchasing eggs from local residents, hatcheries provide an alternate economic incentive to sale for consumption that complies with statutory requirements and thus have gained acceptance among coastal communities over the last decade.[25]

Between 2009 and 2016, a total of 22 local organizations, FIAES, and MARN protected over 11 million sea turtle eggs in hatcheries at 36 beaches that yielded nearly 10 million hatchlings, of which >95% were olive ridleys (Table 2,4).[16] It is important to note that not all olive ridley eggs deposited were protected. It is unclear how many eggs were collected by local residents and sold illegally for human consumption.

Conservation efforts directed towards olive ridleys are focused almost exclusively on nest protection. Increased attention should be given to mitigating in-water threats, such as fisheries-related mortality.

1.5. Research

Key gaps in knowledge regarding olive ridleys center on the implications of hatchery management on temperature regimes and hatchling sex ratios. Given the large number of olive ridley clutches that are incubated in hatcheries each year (Table 1,2),[16] it is imperative that research be conducted to 1) estimate sex ratios of olive ridley hatchlings under natural and manipulated conditions and 2) generate and analyze thermal profiles of nest environments to facilitate effective adaptive management of hatcheries.

2. RMU: Green turtle (*Chelonia mydas*) – Eastern Pacific

2.1. Distribution, abundance, trends

2.1.1. Nesting sites

Green turtle nesting is relatively uncommon in El Salvador, with fewer nests documented each year than both olive ridleys and hawksbills.[16] Green turtle nesting tends to occur between November and February, and has been confirmed at 19 beaches, with most nest protection reported in the south-central to south-eastern part of the country at Punta San Juan (Bahía de Jiquilisco; 6.0 nests/yr), Salamar (8.7 nests/yr), and

El Icacal (5.7 nests/yr) (Fig. 1; Table 1).[16] Similar to the other sea turtle species (except hawksbills), the lack of consistent, long-term monitoring at these beaches impedes the ability to accurately estimate female nesting abundance and necessitates the use of nesting data collected during conservation projects at 36 beaches as a proxy.[16] Therefore, it important to note that these data may be influenced by the level of effort realized by each project, which can vary by beach size, dates of operation, and available funding. Given the inconsistent monitoring of green turtle nesting beaches over time, it is difficult to identify any clear trends in nesting abundance.

2.1.2. Marine areas

Green turtles are commonly observed in marine areas along the entire coast of El Salvador, particularly offshore between 50 and 100 m of depth, at or near rocky reefs, and at or near seagrass beds inside mangrove estuaries (Fig. 2).[9] Green turtles use offshore waters and rocky reefs primarily during October–March, when reproductively active males and females aggregate near nesting beaches.[9] Adult coastal feeding areas sometimes coincide with juvenile developmental habitats, which is observed at the seagrass beds inside the mangrove estuary complex of Bahía de Jiquilisco, where heterogeneous patches of seagrass (*Halodule wrightii*) are distributed across 27.1 km^2.[27] Bahía de Jiquilisco is an important year-round foraging area for immature and mature green turtles, and also serves as a mating area for reproductively active individuals.[11,40] Since 2014, Asociación ProCosta has conducted opportunistic in-water monitoring activities at Bahía de Jiquilisco and has identified over 400 individual green turtles. Green turtle abundance and survival rates have yet to be estimated.

2.2. Other biological data

See Table 1.

2.3. Threats

2.3.1. Nesting sites

Intentional killing of olive green turtles on nesting beaches is extremely rare. However, take of eggs from nesting beaches is common and widespread. Nearly 100% of all green turtle eggs deposited on Salvadoran beaches are collected by local residents for either protection (legal) or human consumption (illegal).[2] However, most sea turtle conservation projects tend to purchase sea turtle eggs for protection during the olive ridley nesting season (August–November) and not during the green turtle nesting season (November–February).[16] Therefore, green turtle eggs collected by local residents often are sold for human consumption, which can fetch a higher price than olive ridley eggs given their larger size.

Coastal development is another severe threat facing green turtles in El Salvador. Most of the Salvadoran coast is heavily developed, which has resulted in extensive nesting habitat degradation and photopollution.[24] Vegetation has been cleared at many beaches, with coastal infrastructure (e.g., walls and houses) often located near the high tide line.[24]

2.3.2. Marine areas

Green turtles found adrift or stranded appear to be a relatively uncommon occurrence along the coast of El Salvador. However, there are diverse threats facing this species in marine areas that may increase the impact on the population as human pressure on these areas continue to increase.[41]

Similar to olive ridleys, shrimp trawls have been shown to interact with green turtles in Salvadoran waters at depths of 10 to 80 m.[10] Inconsistent or ineffective use of turtle excluder devices (TEDs) on active shrimp trawls can result in the incidental capture and drowning of green turtles.[10,41]

Red tides are also implicated in the mortality of dozens of green turtles along the coast of El Salvador.[28] During the red tide event in 2013, high saxitoxin concentrations in samples taken from the organs of dead green turtles suggested intoxication from paralytic shellfish poisoning.[28] Red tide events appear to be increasing in frequency, which can further threaten green turtles in marine areas of El Salvador.

Boat strikes are a growing threat to green turtles at seagrass beds inside mangrove estuaries. Over the last 5 years, there has been an increasing number of local fishers who upgrade from a 40 hp outboard motor to a 75 hp outboard motor, which can reduce the time a turtle at the surface has to react to an approaching boat. As human population grows and use of the estuaries increase, green turtle mortality by boat strikes will likely increase as well.

2.4. Conservation

Conservation efforts directed towards green turtles focus almost entirely nest protection. However, green turtles receive substantially less attention and funding than olive ridleys, despite their conservation status being much more pressing. For example, of the 11 million sea turtle eggs protected between 2009 and 2016, >95% were olive ridleys and <2% were green turtles.[16] Although part of this disparity in protection can be attributed to differences in relative abundance between the two species, part of the disparity can also be attributed to the mismatch in the months in which hatcheries purchase eggs, which correspond to the olive ridley nesting season (August–November) and not to the green turtle nesting season (November–February).[16] To prioritize the protection of green turtle eggs, hatchery operations should better align with the green turtle nesting season.

Increased attention should be given to mitigating in-water threats, such as fisheries-related mortality and boat strikes. This is particularly important at areas where large numbers of green turtles aggregate, such as at the seagrass beds inside Bahía de Jiquilisco.

2.5. Research

Key knowledge gaps exist regarding green turtle abundance and survival at developmental areas in Bahía de Jiquilisco. Since 2014, Asociación ProCosta has collected capture-mark-recapture data on over 400 individual green turtles at the seagrass beds within Bahía de Jiquilisco. There is an urgent need to use this data to estimate abundance and survival rates, so that appropriate in-water threat mitigation strategies can be developed.

3. RMU: Leatherback turtle (*Dermochelys coriacea*) – Eastern Pacific

3.1. Distribution, abundance, trends

3.1.1. Nesting sites

Leatherbacks are the least common species that occur in El Salvador, with a distribution that extends along the entire coast of the country (Fig. 1, Table 1).[16] Leatherback nesting is an exceedingly rare event, which tends to occur sporadically between November and February.[17] Although there is no consistent long-term monitoring of nesting leatherbacks in El Salvador, the rarity of the species makes it likely that all nesting events are reported. Nest protection data collected during sea turtle conservation projects at 36 beaches indicate that there are five priority leatherback nesting beaches in El Salvador: Los Pinos/Cangrejera (2.0 nests/yr), El Pimental (1.7 nests/year), Isla de Mendez (2.0 nests/yr), Isla San Sebastian (1.5 nests/yr), and El Icacal (1.7 nests/yr).[16] Leatherback abundance appears to be decreasing in El Salvador, likely due to the cumulative in-water and terrestrial threats confronting the species in the eastern Pacific region, including El Salvador.[17]

3.1.2. Marine areas

Limited information exists on leatherbacks in marine areas of El Salvador.[17] This is likely because leatherbacks live primarily in cold-water systems off the coast of South America where they feed on jellyfish and only migrate to the tropical waters of Central America to deposit their eggs. Additionally, leatherbacks rarely nest along the Salvadoran coast, which further diminishes opportunities for in-water observation.

3.2. Other biological data

N/A

3.3. Threats

3.3.1. Nesting sites

Intentional killing of leatherbacks on nesting beaches is rare. However, in 2010, there was a case of a local egg collector who killed a nesting leatherback to extract her eggs for human consumption. It turned out that the leatherback had already deposited the eggs on the beach, but the egg collector was unable to locate them and thought the turtle had aborted the nesting attempt.

Take of eggs from nesting beaches is ubiquitous. Nearly 100% of all leatherback eggs deposited on Salvadoran beaches are collected by local residents for either protection (legal) or human consumption (illegal).[2] However, most sea turtle conservation projects tend to purchase sea turtle eggs for protection during the olive ridley nesting season

(August–November) and not during the leatherback nesting season (November–February).[16] Therefore, leatherback eggs collected by local residents often are sold for human consumption, which can fetch a higher price than other sea turtle eggs given their larger size.

Coastal development is another pervasive threat facing green turtles in El Salvador. Most of the Salvadoran coast is heavily developed, which has resulted in extensive nesting habitat degradation and photopollution.[24] Vegetation has been cleared at many beaches, with coastal infrastructure (e.g., walls and houses) often located near the high tide line.[24]

3.3.2. Marine areas

Similar to other sea turtle species, artisanal and industrial fisheries may represent a threat to leatherbacks in marine areas of El Salvador, particularly during migration to nesting beaches and during the internesting period. However, few reports exist of leatherback interactions with fisheries or strandings, except for one verified case between 2006 and 2015.[17]

3.4. Conservation

Conservation efforts directed towards leatherbacks focus entirely nest protection. Similar to green turtles, leatherbacks traditionally receive substantially less attention and funding than olive ridleys, despite their dire conservation status. Because leatherback nesting is extremely rare, hatcheries often are installed at olive ridley nesting beaches and if a leatherback happens to nest at that beach while the hatchery is in operation, the hatchery will purchase it.[17] However, the leatherback nesting season (November–February) does not overlap with typical hatchery operations (August–November).[2,16] Further, because leatherback eggs are highly sensitive to movement-induced mortality, egg transport to oftentimes distant hatcheries can reduce hatching success.[17]

3.5. Research

Fisheries bycatch, particularly in small-scale gillnets and long-lines, represents a major threat to leatherbacks throughout the eastern Pacific region. However, little information exists on leatherback bycatch in fisheries in marine areas of El Salvador. To assess the potential impact of small-scale fisheries on leatherbacks in Salvadoran waters, research should be conducted by employing the standardized bycatch assessment interviews at key ports that were used in Mexico, Nicaragua, Costa Rica, Panama, and Colombia. The results of the assessment would help guide mitigation efforts.

4. RMU: Hawksbill turtle (*Eretmochelys imbricata*) – Eastern Pacific

4.1. Distribution, abundance, trends

4.1.1. Nesting sites

Hawksbills are the second most common sea turtle species in El Salvador,[16] with most nesting occurring April–September and peak nesting June–July.[5,7] Approximately 50% of all known hawksbill nesting activity in the entire eastern Pacific region occurs in El Salvador, which is concentrated at three sites: Los Cóbanos (59.1 nests/yr), Bahía de Jiquilisco (209.8 nests/yr), and Punta Amapala (21.4 nests/yr) (Fig. 1, Table 1).[3,5,7] Asociación ProCosta (formerly ICAPO-El Salvador) has conducted systematic nesting beach monitoring at Bahía de Jiquilisco since 2012 (year-round) and at Los Cóbanos and Punta Amapala since 2014 (April–October).[7] Project personnel and a network of >200 trained local egg collectors monitor hawksbill nesting habitat continually from 18:00 to 06:00 daily by foot and boat in search of female hawksbills (~50% detection) and nests. Each turtle is identified by Inconel tags located on both front flippers and internal passive integrated transponders (PIT tags) in the right front flipper; Inconel and PIT tags are either present from application during previous tagging seasons or are applied after egg laying is finished.[34]

Across the three sites, more than 3500 hawksbill nesting events have been confirmed and 415 hawksbills have been identified since 2008. At Bahía de Jiquilisco, the number of identified nesting hawksbills, including previously unmarked individuals and remigrants, has increased incrementally from 37 turtles in 2012 to 85 turtles in 2020. Caution should be used when viewing these numbers in terms of increased nesting female abundance, as hawksbills can take between 20 and 35 years to reach maturity, and hatchlings produced from conservation efforts beginning in 2008 at Bahía de Jiquilisco likely have yet to reach maturity. Instead, it is probable that annual increases in local participation in beach patrols resulted in a higher percentage of nesting hawksbills being identified. Regardless, the hatchlings currently in the 'pipeline' to maturity from increased nest protection efforts should facilitate an increase in nesting female abundance in the short- to medium-term.

4.1.2. Marine areas

Contrary to their conspecifics in other oceanic regions that utilize long-distance (>2,000 km), offshore migrations, eastern Pacific hawksbills employ short (<300 km), nearshore (<4.2 km) migrations between nesting and foraging areas.[12,13] Indeed, the three primary hawksbill nesting sites in El Salvador (Los Cóbanos, Bahía de Jiquilisco, and Punta Amapala) also serve as important marine areas for the species and are situated in the migration corridor of post-nesting hawksbills.[13]

Los Cóbanos and Punta Amapala are comprised primarily of submerged volcanic reef formations at depths ranging from 0 to 30 m and host diverse marine communities, including corals, sponges, and fishes (Orellana-Amador, 1985; Domínguez-Miranda, 2010). These rocky reefs provide important developmental habitat for immature hawksbills.[5,14]

Bahía de Jiquilisco is the largest mangrove forest in El Salvador (635 km^2) and includes numerous estuaries, channels, and islands.[6] This mangrove estuary provides developmental habitat for immature hawksbills and foraging habitat for mature individuals.[15,22] Since 2016, Asociación ProCosta has conducted systematic in-water monitoring of foraging areas, resulting in the identification of more than 300 individual hawksbills. Hawksbill abundance and survival rates have yet to be estimated.

4.2. Other biological data

See Table 1.

4.3. Threats

4.3.1. Nesting sites

Intentional killing of hawksbills on nesting beaches is extremely rare. However, collection of eggs from nesting beaches is common and widespread. Prior to 2008, nearly 100% of all hawksbill eggs deposited at the three primary nesting sites were collected by local residents and sold for human consumption.[2] Since 2008, approximately 85% of all hawksbill eggs deposited are collected by local residents for protection in hatcheries (legal) and 10% are protected in situ (legal). The remaining 5% are collected by local residents and sold for human consumption (illegal).[5,7,34]

Coastal development is pervasive threat facing hawksbills in El Salvador. Although most of the Salvadoran coast is heavily developed, the three primary hawksbill nesting sites have experienced low to moderate habitat degradation and photopollution.[5,24] Increasingly, however, vegetation is being fragmented or cleared at many beaches, with coastal infrastructure (e.g., walls and houses) encroaching closer to the high tide line.[34]

Climate change is a growing threat to hawksbills in El Salvador. Inshore nesting beaches within Bahía de Jiquilisco are low profile with an elevation of ≤ 1 m above mean sea level and marginal slope ($<2°$), which makes them increasingly vulnerable to sea-level rise.[6,34] Further, most beaches in Bahía de Jiquilisco are backed by human settlements, small-scale agriculture, or mangrove forests, which can restrict inland retreat of beaches.[34]

4.3.2. Marine areas

Artisanal fisheries bycatch poses a major threat to hawksbills in El Salvador, particularly lobster gillnet fishing on rocky reefs at Los Cóbanos and Punta Amapala, and blast fishing (i.e., use of explosives) in Bahía de Jiquilisco.[4,5]

Artisanal lobster gillnet fisheries operating at Los Cóbanos and Punta Amapala have been implicated in interactions with >200 hawksbills since 2012, which may constitute the greatest single source of human-induced in-water mortality for juvenile, sub-adult, and adult hawksbills in the eastern Pacific.[14] The importance of these rocky reef systems as developmental habitat for immature hawksbills further highlights the urgent need to reduce bycatch in lobster gillnet fisheries.

Despite its prohibition in territorial waters and classification as a grave violation by Salvadoran law, blast fishing is a common practice in Bahía de Jiquilisco.[5] Between 2004 and 2020, at least 42 hawksbills were killed by explosives, most of which were mature adults.

4.4. Conservation

Prior to 2007, nearly 100% of all hawksbill eggs deposited in El Salvador were collected by local residents and sold for human consumption.[2] Since 2008, Asociación ProCosta has partnered with local communities living near the three priority nesting sites to protect nearly 100% of hawksbill eggs either in hatcheries or in situ, which has resulted in >3,000 nests protected, >250,000 hatchlings produced, and >400 nesting hawksbills identified.[3,4,5,7,34] Conservation successes have been driven by the Local Hawksbill Conservation Network, which consists of >200 trained local egg collectors who patrol >50 km of nesting habitat daily by foot and boat in search of hawksbills and nests to protect.

At Los Cóbanos and Punta Amapala, Asociación ProCosta has partnered with local fishers to monitor hawksbill bycatch in lobster gillnet fisheries and to identify potential bycatch reduction strategies.[17] During 2015–2021 at Punta Amapala, >5,000 paired gillnet trials were deployed to evaluate the effectiveness of LED-equipped gillnets in reducing hawksbill bycatch while simultaneously maintaining or increasing lobster catch. These trials resulted in a 60% decrease in hawksbill bycatch and a 9% increase in lobster catch income using LED lights. In 2022, Asociación ProCosta and local fishers will begin rolling out voluntary implementation of LED-equipped lobster gillnets at Los Cóbanos and Punta Amapala.

At Bahía de Jiquilisco, despite having identified the deleterious impacts of blast fishing on hawksbills, on local subsistence fishing, and on blast fishers themselves, this illegal practice has yet to be effectively addressed. Eliminating, or at least reducing, blast fishing should be a high priority.

4.5. Research

Prior to 2007, hawksbills were the least understood species in the eastern Pacific.[4] Since 2008, research carried out by members of the Eastern Pacific Hawksbill Initiative (ICAPO in Spanish) across the eastern Pacific have elucidated the biology and ecology of the species, which has guided conservation interventions at nesting beaches and foraging grounds, including in El Salvador (Table 1).

Despite the enormous strides taken to understand and protect hawksbills, it is unclear whether conservation actions have reversed the negative population trend. Furthermore, population-level targets for regional conservation interventions on nesting beaches and in marine habitats are still lacking. Identifying the life stages (e.g., hatchling, adult) where vital rates (e.g., survival, fecundity) that are critical for population growth is imperative for assessing population trajectory and for establishing population-level targets and associated recovery strategies.

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Table 1. Biological and conservation information about sea turtle Regional Management Units in El Salvador.

RMU	L. olivacea EPO	Ref #	C. mydas EPO	Ref #	D. coriacea EPO	Ref #	E. imbricata EPO	Ref #
Occurrence								
Nesting sites	Y	1,2,16	Y	1,2,16	Y	1,2,16,17	Y	3,4,5,6,7,16 34
Oceanic foraging areas	JA	8	JA	9	n/a		J	38
Neritic foraging areas	JA	9,10	JA	9,10,11, 40	n/a		JA	5,9,12,13,14, 15,22, 35, 38
Key biological data								
Nests/yr: recent average (range of years)	>14,554* (2009-2016)	16	>19.6^ (2009-2016)	16	>9.0 (1995-2015)	17	310 (2008-2020)	3,4,5,6,7, 34
Nests/yr: recent order of magnitude	n/a		n/a		n/a		n/a	
Number of "major" sites (>20 nests/yr AND >10 nests/km yr)	≥36	16	0	16	0	16,17	3	5,6,7, 34
Number of "minor" sites (>20 nests/yr OR >10 nests/km yr)	0.84 (11,235,540 eggs)	16	0	16	0	16,17	0	16
Nests/yr at "major" sites: recent average (range of years)	>14,554* (2009-2016)	16	n/a		n/a		310 (2008-2020)	5,6,7, 34

Nests/yr at "minor" sites: recent average (range of years)	n/a		n/a		n/a		n/a	
Total length of nesting sites (km)	177.5	PS	115.5	PS	110.7	PS	87.1	5,6,7, 34
Nesting females / yr	n/a		n/a		n/a		90	6,7,18, 34
Nests / female season (N)	n/a		n/a		n/a		2.1 (190)	7,18
Female remigration interval (yrs) (N)	n/a		n/a		n/a		2.1 (54)	7,18
Sex ratio: Hatchlings (F / Tot) (N)	n/a		n/a		n/a		0.69-0.85 (705 clutches)	34
Sex ratio: Immatures (F / Tot) (N)	n/a		n/a		n/a		0.86 (77)	34
Sex ratio: Adults (F / Tot) (N)	n/a		n/a		n/a		0.53-0.61 (41 clutches from 34 females)	19
Min adult size, CCL or SCL (cm)	n/a		n/a		n/a		Bahía de Jiquilisco = 71.0; Punta Amapala = 62.2	7, 34
Age at maturity (yrs)	n/a		n/a		n/a		Bahía de Jiquilisco = 23	38
Clutch size (n eggs) (N)	96.5 (117)	1	73.0 (24)	PS	64.5 eggs with yolk (13)	17	ANP Los Cóbanos = 132.4 (77); Bahía de Jiquilisco = 167.8 (835); Punta Amapala = 138.7 (41)	5, 7
Emergence success (hatchlings/egg) (N)	0.84 (11,235,540 eggs)	16	0.61 (21)	PS	0.35 (18)	17	ANP Los Cóbanos = 0.63 (237); Bahía de Jiquilisco = 0.53 (1348);	7, 34

							Punta Amapala = 0.72 (93)	
Nesting success (Nests/ Tot emergence tracks) (N)	n/a		n/a		n/a		n/a	
Trends								
Recent trends (last 20 yrs) at nesting sites (range of years)	n/a		n/a		n/a		n/a	
Recent trends (last 20 yrs) at foraging grounds (range of years)	n/a		n/a		n/a		n/a	
Oldest documented abundance: nests/yr (range of years)	22,184 (2010)	16	76 (2012)	16	5 (1995-1996)	17	310 (2008)	5
Published studies								
Growth rates	N		N		N		N	
Genetics	N		N		N		Y	19,20,21,22,36
Stocks defined by genetic markers	N		N		N		Y	20,21,22,36
Remote tracking (satellite or other)	N		N		N		Y	12,13,23,38,39
Survival rates	N		N		N		N	
Population dynamics	N		N		N		N	
Foraging ecology	N		Y	11,40	N		Y	15,35,38,39
Capture-Mark-Recapture	N		Y	11	N		Y	6,7,15,34

Threats								
Bycatch: presence of small scale / artisanal fisheries?	Y (PLL)	8	n/a		n/a		Y (SN, OTH)	5,14
Bycatch: presence of industrial fisheries?	Y (ST)	10	Y (ST)	10	n/a		n/a	
Bycatch: quantified?	N		N		N		Y	14
Intentional killing of turtles	N		N		N		N	
Take. Illegal take of turtles	N		N		N		N	
Take. Permitted/legal take of turtles	N		N		N		N	
Take. Illegal take of eggs	Y	2	Y	2	Y	2,17	Y	2,3,4,5,18,25, 34
Take. Permitted/legal take of eggs	N		N		N		N	
Coastal Development. Nesting habitat degradation	Y	24	Y	24	Y	24	Y	3,4,6,24,34
Coastal Development. Photopollution	Y	24	Y	24	Y	24	Y	24
Coastal Development. Boat strikes	n/a		Y	PS	n/a		Y	PS
Egg predation	n/a		n/a		n/a		Y	PS
Pollution (debris, chemical)	n/a		n/a		n/a		Y	26
Pathogens	n/a		n/a		n/a		n/a	
Climate change	n/a		n/a		n/a		Y	34
Foraging habitat degradation	n/a		Y	27	n/a		Y	13
Other	Y (red tide)	28	Y (red tide)	28	n/a		n/a	
Long-term projects (>5yrs)								
Monitoring at nesting sites (period: range of years)	Y (2010-2020)	16	Y (2010-2020)	16	Y (2010-2020)	16,17	Y (2008-2020)	3,4,5,6,7,34
Number of index nesting sites	4	16	2	16	5	17	3	3,4,5,6,7,16,3 4

Monitoring at foraging sites (period: range of years)	N		Y (2012-2020)	11	N		Y (2012-2020)	15,22,35
Conservation								
Protection under national law	Y	25	Y	25	Y	25	Y	25
Number of protected nesting sites (habitat preservation) (% nests)	≤36 (% varies)	31,32,33	≤20 (% varies)	31,32,33	≤18 (% varies)	31,32,33	3 (95%)	5,7,31,32,34
Number of Marine Areas with mitigation of threats	n/a		n/a		n/a		3	5,7,14,34,35
N of long-term conservation projects (period: range of years)	≥10 (2010-2020)	16	1 (2015-2020)	11	1 (2015-2020)	PS	3 (2008-2020)	5,7,34
In-situ nest protection (eg cages)	N		N		N		Y	6,34
Hatcheries	Y	16	Y	16	Y	16	Y	5,6,7,16,34
Head-starting	N		N		N		N	
By-catch: fishing gear modifications (eg, TED, circle hooks)	Y (ST, PLL)	8,10	Y (ST, PLL)	8,10	n/a		Y (SN)	14
By-catch: onboard best practices	N		N		N		Y	14
By-catch: spatio-temporal closures/reduction	Y (ST)	30	Y (ST)	30	n/a		Y (SN)	29
Other	n/a		n/a		n/a		n/a	
*96.5 eggs/clutch (n = 117 clutches) was used to estimate number of *Lo* clutches[1]								
^73.0 eggs/clutch (n = 24 clutches) was used to estimate number of *Cm* clutches (PS)								
[$]64.5 eggs with yolk/clutch (n = 13 clutches) was used to estimate number of *Dc* clutches[17]								
[%]132.4 eggs/clutch (n = 77 clutches) was used to estimate number of *Ei* clutches[7]								
[#]138.7 eggs/clutch (n = 41 clutches) was used to estimate number of *Ei* clutches[7]								

Table 2. Sea turtle nesting beaches in El Salvador.

RMU / Nesting beach name	Index site	Nests/yr: recent average (range of years)	Crawls/ yr: recent average (range of years)	Central point		Length (km)	% Monitored	Reference #	Monitoring Level (1-2)	Monitoring Protocol (A-F)
LO-EPO*										
Ahuachapán										
Bola de Monte	N	370.5 (2009, 2012)	n/a	-90.110254°	13.735812°	4.0	100.0	16	2	B
Garita Palmera	N	230.5 (2009, 2012)	n/a	-90.070928°	13.719591°	6.7	100.0	16	2	B
Barra de Santiago	N	418.5 (2009, 2012)	n/a	-90.012507°	13.693083°	5.6	100.0	16	2	B
Sonsonate										
Metalío	N	405.0 (2012)	n/a	-89.891733°	13.632187°	6.0	100.0	16	2	B
Los Cóbanos	Y	1255.0 (2009, 2012)	n/a	-89.807170°	13.524219°	7.8	100.0	16	2	B
Barra Ciega	N	197.5 (2009, 2012)	n/a	-89.712139°	13.528635°	2.0	100.0	16	2	B
Playa Dorada	N	750.7 (2009, 2012, 2016)	n/a	-89.65495	13.52928	4.9	100.0	16	2	B

				0°	9°					
La Libertad										
El Zonte	N	26.0 (2009)	n/a	-89.442071°	13.495081°	1.9	100.0	16	2	B
El Majahual	N	227.0 (2009)	n/a	-89.365790°	13.490160°	1.5	100.0	16	2	B
San Blas	N	144.0 (2009, 2012, 2016)	n/a	-89.357605°	13.486021°	1.6	100.0	16	2	B
San Diego	Y	1381.3 (2009, 2012, 2016)	n/a	-89.278185°	13.477297°	9.0	100.0	16	2	B
El Amatal	N	339.0 (2009, 2012, 2016)	n/a	-89.242829°	13.461899°	1.0	100.0	16	2	B
Toluca	Y	823.5 (2009, 2012)	n/a	-89.225890°	13.453534°	3.9	100.0	16	2	B
Boca Poza	N	142.0 (2009)	n/a	-89.204077°	13.442142°	1.5	100.0	16	2	B
Los Pinos/Cangrejera	N	771.5 (2009, 2012)	n/a	-89.183532°	13.432252°	4.1	100.0	16	2	B
La Paz										
Las Bocanitas	N	416.5 (2009, 2012)	n/a	-89.162258°	13.421546°	1.6	100.0	16	2	B
Amatecampo	N	405.0 (2009, 2012)	n/a	-89.143259°	13.411992°	1.8	100.0	16	2	B
La Zunganera	N	382.0 (2009, 2012)	n/a	-89.12490	13.40202	2.8	100.0	16	2	B

				8°	1°					
El Pimental	N	520.5 (2009, 2012)	n/a	- 89.07936 0°	13.37698 7°	4.5	100.0	16	2	B
San Marcelino/Las Hojas	N	360.0 (2016)	n/a	- 89.04207 0°	13.35734 6°	4.9	100.0	16	2	B
Costa del Sol	N	673.7 (2009, 2011-2016)	n/a	- 88.92298 1°	13.30639 0°	13.7	100.0	16	2	B
Isla Tasajera	Y	1036.0 (2009, 2012, 2016)	n/a	- 88.85354 5°	13.27022 1°	6.9	100.0	16	2	B
San Vicente										
Isla Montecristo	N	777.7 (2009, 2012-2016)	n/a	- 88.78857 4°	13.24445 7°	7.0	100.0	16	2	B
Usulután										
San Juan del Gozo	N	743.0 (2009, 2012)	n/a	- 88.75149 0°	13.23231 6°	3.0	100.0	16	2	B
Isla de Méndez	N	723.5 (2009, 2012)	n/a	- 88.71558 5°	13.22476 2°	5.6	100.0	16	2	B
Ceiba Doblada	N	282.5 (2012)	n/a	- 88.64427 6°	13.21330 7°	8.5	100.0	16	2	B
Corral de Mulas	N	471.0 (2009-2011)	n/a	- 88.54262 1°	13.19286 4°	4.7	100.0	16	2	B
El Icaco	N	484.5 (2009, 2011)	n/a	- 88.52535 3°	13.18654 2°	2.5	100.0	16	2	B
Punta San Juan	N	227.0 (2011)	n/a	- 88.48940	13.17604	7.4	100.0	16	2	B

				7°	0°					
Isla San Sebastián	N	684.0 (2009, 2012, 2016)	n/a	-88.408611°	13.162931°	12.6	100.0	16	2	B
El Espino	N	241.7 (2009, 2012, 2016)	n/a	-88.303310°	13.172478°	6.5	100.0	16	2	B
Salamar	N	92.5 (2009, 2012)	n/a	-88.235933°	13.163123°	2.8	100.0	16	2	B
La Unión										
El Icacal	N	137.0 (2009, 2012, 2016)	n/a	-88.015986°	13.165526°	9.4	100.0	16	2	B
Punta Amapala	N	170.5 (2012, 2016)	n/a	-87.936131°	13.159791°	6.5	100.0	16	2	B
El Tamarindo	N	61.4 (2009-2010, 2012-2016)	n/a	-87.916344°	13.183208°	1.9	100.0	16	2	B
El Majahual (Isla Meanguera)	N	49.0 (2009, 2016)	n/a	-87.709121°	13.170171°	1.4	100.0	16	2	B
CM-EPO^										
Sonsonate										
Los Cóbanos	N	1.3 (2009, 2012, 2016)	n/a	-89.807170°	13.524219°	7.8	100.0	16	2	B
Barra Ciega	N	0.5 (2009, 2012)	n/a	-89.712139°	13.528635°	2.0	100.0	16	2	B
Playa Dorada	N	1.0 (2009, 2012, 2016)	n/a	-89.65495	13.52928	4.9	100.0	16	2	B

				0°	9°					
La Libertad	N									
San Diego	N	0.3 (2009, 2012, 2016)	n/a	-89.654950°	13.529289°	9.0	100.0	16	2	B
La Paz										
El Pimental	N	2.5 (2009, 2012)	n/a	-89.079360°	13.376987°	4.5	100.0	16	2	B
San Marcelino/Las Hojas	N	1.0 (2016)	n/a	-89.042070°	13.357346°	4.9	100.0	16	2	B
Costa del Sol	N	2.7 (2009, 2011-2016)	n/a	-88.922981°	13.306390°	13.7	100.0	16	2	B
Isla Tasajera	N	3.7 (2009, 2012, 2016)	n/a	-88.853545°	13.270221°	6.9	100.0	16	2	B
San Vicente										
Isla Montecristo	N	1.0 (2009, 2012-2016)	n/a	-88.788574°	13.244457°	7.0	100.0	16	2	B
Usulután										
Isla de Méndez	N	1.0 (2012)	n/a	-88.715585°	13.224762°	5.6	100.0	16	2	B
Corral de Mulas	N	1.0 (2009-2011)	n/a	-88.542621°	13.192864°	4.7	100.0	16	2	B
El Icaco	N	3.5 (2009, 2011)	n/a	-88.525353°	13.186542°	2.5	100.0	16	2	B
Punta San Juan	Y	6.0 (2011-2016)	n/a	-88.48940	13.17604	7.4	100.0	16,PS	2	B

				7°	0°					
Isla San Sebastián	N	0.9 (2009, 2011-2016)	n/a	-88.408611°	13.162931°	12.6	100.0	16	2	B
Salamar	Y	8.7 (2009, 2012, 2016)	n/a	-88.235933°	13.163123°	2.8	100.0	16	2	B
La Unión										
El Icacal	N	5.7 (2009, 2012, 2016)	n/a	-88.015986°	13.165526°	9.4	100.0	16	2	B
Punta Amapala	N	2.7 (2009, 2012, 2016)	n/a	-87.936131°	13.159791°	6.5	100.0	16	2	B
El Tamarindo	N	0.1 (2009-2010, 2012-2016)	n/a	-87.916344°	13.183208°	1.9	100.0	16	2	B
El Majahual (Isla Meanguera)	N	0.5 (2009, 2016)	n/a	-87.709121°	13.170171°	1.4	100.0	16	2	B
DC-EPO$										
Ahuachapán										
Garita Palmera	N	0.5 (2009, 2012)	n/a	-90.070928°	13.719591°	6.7	100.0	16	2	B
Barra de Santiago	N	1.0 (2009, 2012, 2014)	n/a	-90.012507°	13.693083°	5.6	100.0	16,17	2	B
Sonsonate										
Los Cóbanos	N	0.5 (2009, 2012, 2014, 2016)	n/a	-89.807170°	13.524219°	7.8	100.0	16,17	2	B
Barra Ciega	N	0.3 (2009, 2012, 2014)	n/a	-		2.0	100.0	16,17	2	B

				89.71213 9°	13.52863 5°					
La Libertad										
San Diego	N	0.8 (2009, 2012, 2014, 2016)	n/a	- 89.65495 0°	13.52928 9°	9.0	100.0	16,17	2	B
El Amatal	N	0.3 (2009, 2012, 2016)	n/a	- 89.24282 9°	13.46189 9°	1.0	100.0	16,17	2	B
Los Pinos/Cangrejera	Y	2.0 (2009, 2012, 2014)	n/a	- 89.18353 2°	13.43225 2°	4.1	100.0	16,17	2	B
La Paz										
La Zunganera	N	0.7 (2009, 2012, 2014)	n/a	- 89.12490 8°	13.40202 1°	2.8	100.0	16,17	2	B
El Pimental	Y	1.7 (2009, 2012, 2014)	n/a	- 89.07936 0°	13.37698 7°	4.5	100.0	16,17	2	B
Costa del Sol	N	1.1 (2009, 2011-2016)	n/a	- 88.92298 1°	13.30639 0°	13.7	100.0	16,17	2	B
Usulután										
San Juan del Gozo	N	0.3 (2009, 2012, 2014)	n/a	- 88.75149 0°	13.23231 6°	3.0	100.0	16,17	2	B
Isla de Méndez	Y	2.0 (2009, 2012)	n/a	- 88.71558 5°	13.22476 2°	5.6	100.0	16,17	2	B
El Icaco	N	0.7 (2009, 2011, 2014)	n/a	- 88.52535 3°	13.18654 2°	2.5	100.0	16	2	B
Punta San Juan	N	0.5 (2011-2012)	n/a	- 88.48940 7°	13.17604 0°	7.4	100.0	16	2	B

Isla San Sebastián	Y	1.5 (2009, 2012, 2014, 2016)	n/a	-88.408611°	13.162931°	12.6	100.0	16,17	2	B
El Espino	N	0.5 (2009, 2012, 2014, 2016)	n/a	-88.303310°	13.172478°	6.5	100.0	16,17	2	B
La Unión										
El Icacal	Y	1.7 (2009, 2012, 2016)	n/a	-88.015986°	13.165526°	9.4	100.0	16	2	B
Punta Amapala	N	0.7 (2009, 2012, 2016)	n/a	-87.936131°	13.159791°	6.5	100.0	16	2	B
EI-EPO										
Ahuachapán										
Garita Palmera[%]	N	1.0 (2009)	n/a	-90.070928°	13.719591°	6.7	100.0	16	2	B
Sonsonate										
Los Cóbanos	Y	59.1 (2008, 2010, 2014-2020)	n/a	-89.807170°	13.524219°	7.8	100.0	5,6,7,16,PS	1	B
Barra Ciega[%]	N	1.0 (2009, 2012)	n/a	-89.712139°	13.528635°	2.0	100.0	16	2	B
Usulután										
Bahía de Jiquilisco (inshore beaches)	Y	209.8 (2008-2020)	n/a			42.1	100.0	5,6,7,16,34,PS	1	B
El Espino	N	0.3 (2009, 2012, 2016)	n/a	-88.303310°	13.172478°	6.5	100.0	16	2	B
Salamar	N	1.0 (2009, 2012)	n/a	-88.23593	13.16312	2.8	100.0	16	2	B

				3°	3°					
La Unión										
El Icacal#	N	2.3 (2009, 2012, 2016)	n/a	-88.015986°	13.165526°	9.4	100.0	16	2	B
Punta Amapala#	Y	21.4 (2008-2009, 2012, 2014-2020)	n/a	-87.936131°	13.159791°	6.5	100.0	5,6,7,16,PS	1	B
El Tamarindo#	N	0.4 (2009, 2012-2016)	n/a	-87.916344°	13.183208°	1.9	100.0	16	2	B
El Majahual (Isla Meanguera)#	N	2.5 (2009, 2016)	n/a	-87.709121°	13.170171°	1.4	100.0	16	2	B
*96.5 eggs/clutch (n = 117 clutches) was used to estimate number of *Lo* clutches[1]										
^73.0 eggs/clutch (n = 24 clutches) was used to estimate number of *Cm* clutches (PS)										
$64.5 eggs with yolk/clutch (n = 13 clutches) was used to estimate number of *Dc* clutches[17]										
%132.4 eggs/clutch (n = 77 clutches) was used to estimate number of *Ei* clutches[7]										
#138.7 eggs/clutch (n = 41 clutches) was used to estimate number of *Ei* clutches[7]										

Table 3. International conventions protecting sea turtles and signed by El Salvador.

International Conventions	Signed	Binding	Compliance measured and reported	Species	Conservation actions	Relevance to sea turtles
Convention on Biological Diversity	Y	Y	Y	LO,CM,DC,EI	Facilitates conservation planning and sustainable use of natural resources.	"…obliged to develop (or adapt existing) national strategies, plans, or programs for the conservation and sustainable use of biological diversity." This includes sea turtles.
Inter-American Convention (IAC) for the Protection and Conservation of Sea Turtles	N	n/a	n/a	n/a	n/a	n/a
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	Y	Y	Y	LO,CM,DC,EI	Deincentivizes harvest of sea turtle products.	Prohibits international trade of sea turtle products.
Ramsar Convention	Y	Y	Y	n/a	Facilitates wetland conservation.	"...provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources."

Table 4. Projects and databases on sea turtles in El Salvador.

#	RMU	Country	Region / Location	Project Name or descriptive title	Key words	Start date	End date	Leading organisation	Public/ Private	Collaboration with	Reports / Information material	Current Sponsors
T4. 1	EPO	El Salvador	El Icacal	n/a	n/a	n/a	n/a	ADEL LA UNION	Private	MARN		FIAES
T4. 2	EPO	El Salvador	Isla de Méndez	n/a	n/a	n/a	n/a	ADESCOIM	Private	MARN		FIAES
T4. 3	EPO	El Salvador	Barra de Santiago	n/a	n/a	n/a	n/a	AMBAS	Private	MARN		FIAES
T4. 4	EPO	El Salvador	Las Bocanitas	n/a	n/a	n/a	n/a	Arenas del Pacífico	Private	MARN		SELF FUNDED
T4. 5	EPO	El Salvador	Isla San Sebastián	n/a	n/a	n/a	n/a	ASIBAHIA	Private	MARN		FIAES
T4. 6	EPO	El Salvador	Isla Montecristo, Ceiba Doblada	n/a	n/a	n/a	n/a	Asociación Mangle	Private	MARN		FIAES
T4. 7	EPO	El Salvador	Los Pinos/Cangrejera	n/a	n/a	n/a	n/a	ATOPLOCPC	Private	MARN		FIAES
T4. 8	EPO	El Salvador	El Tular, Corral de Mulas	n/a	n/a	n/a	n/a	Ayuda en Acción	Private	MARN		FIAES
T4.	EP	El	Isla San	n/a	n/a	n/a	n/a	CODEPA	Priv	MARN		FIAES

9	O	Salvador	Sebastián						ate			
T4.10	EPO	El Salvador	Costa del Sol	n/a	n/a	n/a	n/a	Fundación Domenech	Private	MARN		FIAES
T4.11	EPO	El Salvador	Los Cóbanos Reef Protected Area	n/a	n/a	n/a	n/a	FUNDARRECIFE	Private	MARN		FIAES
T4.12	EPO	El Salvador	El Tamarindo	n/a	n/a	n/a	n/a	FUNDATAMARINDO	Private	MARN		FIAES
T4.13	EPO	El Salvador	Icacal, El Majahual (Meanguera)	n/a	n/a	n/a	n/a	FUNSALPRODESE	Private	MARN		FIAES
T4.14	EPO	El Salvador	Playa Dorada, San Blas, San Diego, El Amatal, Isla Tasajera	n/a	n/a	n/a	n/a	FUNZEL	Private	MARN		FIAES
T4.15	EPO	El Salvador	Los Pinos/Cangrejera	n/a	n/a	n/a	n/a	FUTECMA	Private	MARN		FIAES
T4.16	EPO	El Salvador	Bahía de Jiquilisco, Los Cóbanos Reef Protected Area, Punta Amapala	n/a	n/a	n/a	n/a	ProCosta/ICAPO	Private	MARN		USFWS, NFWF, Wild Earth Allies
T4.	EP	El	San	n/a	n/a	n/a	n/a	Madre Cría	Priv	MARN		FIAES

17	O	Salva dor	Marcelino/ Las Hojas						ate			
T4. 18	EP O	El Salva dor	San Juan del Gozo	n/a	n/a	n/a	n/a	MSM	Priv ate	MARN		FIAES
T4. 19	EP O	El Salva dor	El Espino, Salamar	n/a	n/a	n/a	n/a	Oikos	Priv ate	MARN		FIAES
T4. 20	EP O	El Salva dor	El Espino	n/a	n/a	n/a	n/a	PROMESA	Priv ate	MARN		FIAES
T4. 21	EP O	El Salva dor	Costa del Sol	n/a	n/a	n/a	n/a	SalvaNatura	Priv ate	MARN		FIAES
T4. 22	EP O	El Salva dor	El Amatal, Toluca, Salamar, El Icacal	n/a	n/a	n/a	n/a	VIVAZUL	Priv ate	MARN		PLANT A FISH

Figure 1. Main sea turtle nesting beaches in El Salvador.

Fi gure 2. Marine areas in EL Salvador.

Nicaragua

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1. RMU: Olive ridley (*Lepidochelys olivacea*) – Eastern Pacific

1.1. Distribution, abundance, trends

Olive ridley nesting occurs at least sporadically in every sandy beach on the pacific coast of Nicaragua. Two arribada beaches, La Flor and Chacocente (Figure 1), account for the majority of the nesting output. Between 2012 and 2017, together, these rookeries hosted an average of 190,000 nests/year, accounting for nearly 95% of the reported nesting in the Pacific coast of Nicaragua. Despite the long-term history of conservation and monitoring at these sites (early 1980s in Chacocente and early 1990s in la Flor), there is a substantial lack of published information available.

The annual nesting data in La Flor (2003-2017) and Chacocente (2000-2017) suggest a positive to stable nesting trend during the past 15 years (Figure 2). Particularly, the annual nest count increased in the first half of the 2000s decade, and stabilized during the following ten years, between 2006 and 2017.

1.1.1. Nesting sites

Olive ridley nesting occurs at least sporadically in most sandy beaches along the 410 km of coastline of the Nicaraguan Pacific. Most nesting activity overlaps with the rainy season between July and November, peaking in September and October. The average count of clutches per nesting beach reaches several hundred in solitary nesting beaches (Table 2). Regarding the two arribada nesting beaches, between 2011 and 2016, MARENA reported an average of 136 and 57 thousand nests per season in La Flor and Chacocente respectively.

Probably, the olive ridley nest counts presented in this report under estimate nesting abundance for the pacific coast of Nicaragua for several reasons. First, the arribada size are computed using a census method (MARENA, 2007)[1], this method is probably unsuitable to count the clutches during large arribadas, in which monitoring staff would likely become overwhelmed by large numbers of simultaneous nesting females. Second, some projects (e.g. Padre Ramos, Vera Cruz de Acayo) primarily focus in other sea turtle species (e.g. hawksbill or leatherbacks), which have different nesting seasons than olive ridley. Consequently, they only account for a fraction of the annual nesting at those sites. Third, some projects, for example projects in El Coco and Ostional, only report the clutches that are relocated in the hatcheries (Peñalba and Coronado, 2016)[2]. Fourth, some small conservation initiatives, especially various small hatchery projects did not publish their results. Finally, several olive ridley nesting beaches are not being monitored or protected (MARENA, 2006)[3]. Further analysis is required to draw robust conclusions about trends and population size.

1.1.2. Marine areas

There are few studies addressing olive ridley in their marine habitat in the Pacific coast of Nicaragua. Most information about geographic occurrence is anecdotal or based on bycatch reports. Adult females and males concentrate near shore during the early months of the nesting season. From late May to early July, it is common to observe tens to hundreds of mating turtles, within a radius of few kilometers from the arribada nesting beaches (Urteaga, 2010, person. comm.).

1.2. Other biological data

Some basic indicators collected in nesting beach such as clutch size, curve carapace length and hatch success show some contrast between arribada and solitary nesting beaches, however, the statistical significance of these differences have not been analyzed (Table 2). For example, average clutch size reported in solitary nesting beaches (85-87.1 eggs/clutch) seems slightly smaller than the reported on arribada nesting beaches (95 eggs/clutch). Additionally, the average hatching rates are larger in solitary nesting beaches (68.6% - 84.7%), than the arribada nesting beaches (6% -16%). The relatively low hatching rates in arribada nesting beaches have been extensible documented in the literature and responds to various environmental and nesting density dependent factors.

1.3. Threats

1.3.1. Nesting beach

The most important threats to olive ridley in the Pacific of Nicaragua have been historically the overharvesting of eggs and fishery bycatch. Other threats such as coastal development (e.g. light pollutions, construction in nesting habitat), oil spills, plastic pollution, and climate change are considered present and concerning, but remain highly unassessed and unaddressed.

Egg collection for human consumption has been legally banned since 2005, however is the most conspicuous threat and the one that have received more attention during the last couple of decades (Hope, 2002[4]; MARENA, 2006[3]; Campbell, 2007[5]; Madrigal-Ballestero and Jurado, 2017[6]). As in most part of Central America, sea turtle eggs are considered a delicatessen and aphrodisiac dish; they are highly demanded in cities, and touristic places, incentivizing an illegal market. Egg collectors are local coastal residents generally leaving under the line of poverty. The root causes of egg collection are complex and based in multiple sociocultural, economic and institutional factors.

In many solitary nesting, beaches the response to egg collection has been the implementation of sea turtle hatcheries. While hatcheries mitigate the loss of eggs to poaching, they also encompasses risks associated to the manipulation of eggs, which might affect sex ratios, and the health of hatchlings. These risks remained highly undressed at the date of the compilation of the data for this report.

1.3.2. Marine areas

Death stranded turtles, presumably by fisheries interaction or algal blooms have been observed by staff of conservation projects and local people. Between 2010 and 2017, Fauna & Flora International documented 477 stranded marine turtles from which 435 were olive ridley (Gadea, 2017, pers. comm.).
Multiple small-scale fisheries operate in the pacific coast of Nicaragua using diversity of legal and illegal fishing gears and practices. A survey conducted by Fauna and Flora International found that 77% of interviewed fishers (n= 55) recalled sea turtle bycatch interactions (Gadea, 2017, pers. comm.). In particular, small-scale fishers using fish gill-nets in León and Chinandega are frequently incidentally fishing sea turtles. While olive ridley bycatch is frequent, there is lack of sufficient information to estimate its prevalence and magnitude.

Anecdotal information also indicates that while most of incidental caught turtles are discarded or released, some fishers kill gravid females to extract the eggs. In addition, fishers in communities such as Masachapa, Aserradores, account for incidents where olive ridley have been purposively caught for meat, particularly in periods where fish catch of commercial species is low. Fishers also mentioned that turtle meat is mostly consumed locally, although some informants suggested that there is a small demand in cities. These type of incidents seem to be rare although concerning, given the risk of proliferation.

1.4. Conservation

La Flor and Chacocente are within wildlife refuges under the management of the Natural Resources and Environment Ministry of Nicaragua (MARENA). The arribada nesting beaches are protected by a program lead by MARENA in collaboration with the Nicaraguan army and local communities. Most nests are protected *in situ*. Nest protection and other conservation activities in solitary nesting beaches are usually implemented by private stakeholders such as NGOs, universities, or small touristic business. These projects tend to use material incentives (usually cash) to motivate egg collectors to provide the clutches for protection. Nests are protected *in situ* and most commonly in hatcheries.

Both arribada nesting beaches, as well as several solitary nesting beaches are covered by conservation projects (Table 2). Unfortunately, the lack of public information makes difficult to provide figures of the percentage of clutches protected. According to information available, the protection rates ranged from 23% to 87% (Table 2). Most likely, nearly 100% of the olive ridley eggs are lost to egg collection on those beaches that do not host conservation projects.

1.5. Research

Most recent research (2016-2021) on olive ridleys in Nicaragua focus on the monitoring of nesting beaches and hatchery operations. However, as expressed previously, this work in rarely published.
Recent publications include two papers analyzing the population genetics at the Eastern Pacific scale, which include sample collected in Nicaragua (Rodríguez-Zárate *et al.*, 2018[7]; Silver-Gorges *et al.*, 2020[8]). As well one study reporting the first molecular detection of fibropapillomatosis virus in olive ridley turtles from Nicaragua (Chaves *et al.*, 2017)[9].

2. RMU: Hawksbill turtle (*Eretmochelys imbricata*) – Eastern Pacific

As in the rest of the region, the Eastern Pacific hawksbill has been the most recently sea turtle population discovered in Nicaragua. Between 2008 and 2020, this management unit enjoyed from considerable attention, research and conservation, with respect to other RMU.

2.1. Distribution, abundance, trends

2.1.1. Nesting sites

The Nicaraguan rookeries along with the Salvadorians concentrate more than 90% of the known nesting activity of hawksbill in the Eastern Pacific region (Gaos, Liles, *et al.,* 2017)[10]. In average, Nicaragua hosted 280 nests of hawksbill per year between 2012 and 2017 (Table 2) (Altamirano, 2016[11]; Rivera, Gadea and Salazar, 2017[12]. ICAPO researchers summarized the nesting demographic data at the regional level, including the results of the various Nicaraguan nesting sites (Gaos, Liles, *et al.*, 2017)[10]. The most important nesting areas are located in the northern Pacific in Padre Ramos and Aserradores (~ 257 nests/season; Table 2, Figure 1).

2.1.2. Marine areas

As described in the olive ridley section, most of the marine areas of the Eastern Pacific coast of Nicaragua are understudied, however, there have been important progress on the research related to the Eastern Pacific hawksbill. Researchers have found, that in contrast to other sea turtles, the Eastern Pacific hawksbill have a relatively small home range, they remain close to shore (Gaos *et al.*, 2012[13]; Gaos, Lewison, *et al.*, 2017)[14]. All stages of hawksbill use the mangrove-lined estuaries of the Pacific coast and Fonseca Gulf, especially, near nesting sites in Padre Ramos and Aserradores. In addition, juveniles also are found in rocky reef along the shore and in relatively shallow waters, for example near La Flor wildlife refuge, and La Salvia (Liles *et al.*, 2017)[15]. Genetic and satellite telemetry studies suggest that hawksbill rookeries are highly structured and that they might be considered as independent management units (Gaos *et al.*, 2012[13,16]; Gaos *et al.*, 2018).

2.2. Other biological data

For common indicators of nesting ecology see Table 2.

2.3. Threats

2.3.1. Nesting sites

The situation of threats affecting hawksbill in the nesting beach is similar to the one described for olive ridley. The most conspicuous threat has been the collection of eggs for human consumption. While other threats such as climate change, and coastal degradation caused by development, agriculture and aquaculture are increasingly concerning, these remain largely unassessed and unaddressed.

2.3.2. Marine areas

The situation of threats affecting hawksbills in the marine areas is similar to the described for olive ridley. Death stranded turtles, presumably by fisheries interaction or algal blooms, are frequently observed by staff of conservation projects and local people. Between 2010 and 2017, Fauna & Flora International documented 477 stranded marine turtles from which 18 were hawksbills (Gadea, 2017, pers. comm.). However, there are not formal publications reporting these observations.

Bottom-set lobster gill net bycatch is one of the most important causes of hawksbill juveniles mortality in the Gulf of Fonseca, specifically near La Salvia (Liles *et al.*, 2017)[15]. This type of interaction is probably occurring in other areas where this type of fishery is common (e.g. Aserradores).

In addition, the proliferation of blast fishing has been a subject of concern among government and conservation NGOs (M. Salazar, 2015)[17]. Although, there are no documented cases of blast fishing affecting sea turtles in Nicaragua, it is considered as high threat to all species and habitat.

As described in the case of olive ridley, the direct take of sea turtles to extract the eggs of gravid females, and/or use of meat, occurs sporadically along the coast. This use of turtles is provably driven by socio economic causes that are not well understood. This phenomenon remains unassessed formally.

There are not reports of hawksbill taken for the use of its shell in the pacific coast of Nicaragua. While Nicaragua is considered a hot spot for the illegal trade of hawksbill handcrafts and jewellery, most, if not all, the shell supply is from hawksbills caught in the Caribbean coast (Nahill, von-Weller and Barrios-Garrido, 2020)[18].

2.4. Conservation

The NGO Fauna & Flora International implements the nesting beach and in water conservation projects in Aserradores and Padre Ramos since 2010 and 2014 respectively. The monitoring of these sites cover most of the nesting period (May to September) (Altamirano, 2016[11]; Rivera, Gadea and Salazar, 2017[12]), including systematic counting of the nests, and tagging of nesting females. Temporal and spatial coverage is nearly 100%. These projects have protected over 90% of clutches (Table 2). Most of clutches protected in these projects are relocated to hatcheries, and smaller percentage are protected *in situ*.

On the other side the NGO Paso Pacífico coordinate nesting beach protection in the south Pacific near La Flor wildlife refuge.

2.5. Research

Between 2016 and 2021, researchers produced seven peer-reviewed articles using data collected in the pacific of Nicaragua. All this publications involved at least one researcher from Nicaragua. Two of these publications addressed nesting ecology and conservation. Gaos *et al.* (2017)[10] summarize hawksbill nesting monitoring information from1983 to 2016 in 9 confirmed nesting locations, two of which are Aserradores and Padre Ramos in Nicaragua. Liles *et al.* (2019)[19] examine the variability of the nesting habitat, it environmental condition and association with hatching rates and sex ratio output in Nicaragua and El Salvador.

Tauer *et al.* (in preparation)[20] produced a baseline study of health parameters in haematology and blood biochemistry as well as tested for heavy metals and persistent organic pollutants.
Liles *et al.* (2017)[15] report bycatch rates in the lobster gill net fishery in La Salvia in the Gulf of Fonseca, Nicaragua, along with two other locations in El Salvador. Two articles focused on population genetics. Gaos, Lewison, *et al.* (2017)[14] conduct research to study the genetic structure of juvenile hawksbill turtles in foraging grounds and their correlation with the genetic structure of nesting beaches, describing a pattern of natal foraging philopatry. Gaos *et al.* (2018)[16] use mitochondrial DNA sequences and mixed-stock analysis to further understand the genetic population patterns and variability as well as to discuss the ecological implications of their findings.

The last two papers focus on social aspects of hawksbill conservation. Liles *et al.* (2016)[21] critically review the environmental education campaign the Hawksbill Cup and the role of hawksbill conservation as an iterative process in which community reinforce and shapes its collective identity and environment. Wedemeyer-Strombel *et al.* (2019)[22] facilitates participatory mapping of in water distribution on hawksbills in Padre Ramos in Nicaragua, and Bahia de Jiquilisco in El Salvador estuaries. This work uses

Participatory Action Research and Trinity of Voice methodology to facility coproduction of knowledge with local fishers. The article provides a critical perspective and in-depth description of the experience, which helps to contextualize the essential role of local communities in hawksbill conservation.

3. RMU: Green turtle (*Chelonia mydas*) – Eastern Pacific

3.1. Distribution, abundance, trends

3.1.1. Nesting sites

Chelonia mydas nests in several locations along the Pacific coast of Nicaragua, the most important beaches are located in the south Pacific (Table 2, Figure 1). Brasilón and Playa Escondida are the densest. Between 2013 and 2015, in these two locations, the NGO Paso Pacífico reported an average of 182 nests per season (Table 2). These data were collected from systematic monitoring efforts based in nighty patrols, count of nests and tagging of females (Table 2). No studies analysing trends have been produced.

3.1.2. Marine areas

There is no information available.

3.3. Threats

3.3.1. Nesting sites

The situation of threats affecting pacific green turtles in the nesting beach is similar to the situations described for olive ridley. The most conspicuous threat has been the collection of eggs for human consumption. While other threats such as climate change, or coastal degradation caused by development, agriculture and aquaculture are increasingly concerning, these remain largely unassessed and unaddressed.

3.3.2. Marine areas

Threats affecting the pacific green sea turtle in the marine areas of Nicaragua are believed to be similar to those described for hawksbill and olive ridley. However, these remain largely understudied.

Between 2010 and 2017, Fauna & Flora International documented 477 stranded marine turtles from which 24 were hawksbills (Gadea, 2017, pers. comm.). However, there are not formal publications reporting these observations.

3.4. Conservation

Paso Pacífico started conservation and monitoring of nesting areas in the south Pacific in 2007. Working protocols varies across sites (See Table 2). Paso Pacífico protects most of the nests *in situ* (Peñalba and Coronado, 2016[2]; Padilla, Salazar and Gadea, 2017[23]) cooperating with local communities and coastal hotels.

3.5. Research

There are not recent publications covering this species in the Pacific coast of Nicaragua.

4. RMU: Leatherback turtle (*Dermochelys coriacea*) – Eastern Pacific

4.1. Distribution, abundance, trends

4.1.1. Nesting sites

Leatherback systematic monitoring and conservation efforts in Nicaragua started after 2001. There are few available records of earlier years. Morales (1983)[24] reported the occurrence of one hundred leatherback nests in one single night in Veracruz de Acayo. This observation indicates that the Veracruz de Acayo rookery had a size of at least 100 females in the early 1980s, although this is probably a very conservative estimation. During the 1990's Nica Ambiental, a national NGO, conducted intermittent visits to the same beach to tag and count leatherback females. By then the number of nests had dropped dramatically consistently with the collapsed documented on primary nesting areas in Costa Rica and Mexico. In 2004, Chacón (2004)[25] summarized this historical information for the Inter-American Convention for the Protection of Sea turtles.

Individual nesting females were identified using PIT tags in Veracruz de Acayo since 2002 and Salamina since 2008) (Salazar, 2015[26]; Jarquín *et al.*, 2017[27]). Until 2017, 83 females were tagged (Veracruz de Acayo=52, Salamina = 31). In average seven females and 28 nests were recorded per season between 2008 and 2017 in these two nesting beaches. In Veracruz, Fauna & Flora International reported a statistically significant decline between 2002 and 2017. In the first half of the 2000s decade, annual nesting ranged from 20 to 80 nests per season. During the first half of the 2010s decade, the average nesting did not surpass 10 nests per season (Tables 1 and 2).

4.1.2. Marine areas

There in few knowledge of the leatherback sea turtle use of marine habitats or in water population studies in the pacific coast of Nicaragua.

4.3. Threats

4.3.1. Nesting sites

The situation of threats affecting leatherbacks in the nesting beach is similar to the situations described for olive ridley. The most conspicuous threat has been the collection of eggs for human consumption. While other threats such as climate change, or coastal degradation caused by development, agriculture and aquaculture are increasingly concerning, these remain largely unassessed and unaddressed.

4.3.2. Marine areas

Leatherback interactions with small-scale fisheries in the Pacific of Nicaragua was studied by Ortiz-Alvarez *et al.* (2020)[28], as part of a regional study of bycatch in internesting areas of the Eastern Pacific. In Nicaragua, researcher surveyed 110 fishers from six locations: Estero Padre Ramos, Los Zorros, Jiquilillo, Poneloya, Las Peñitas, and Masachapa between October of 2016 and March of 2017. This study estimated that 52 ± 27 leatherback were incidentally caught per year in the six Nicaraguan ports, placing Nicaragua as one of the countries with the highest percentage of fishers reporting leatherback bycatch (15 %).

4.4. Conservation

Since 2001, NGOs and Universities increased leatherback monitoring and conservation, particularly in three beaches: Veracruz de Acayo, Juan Venado, and Salamina. In addition, leatherback nests sporadically in various beaches (Table 2, Figure 1). Monitoring in Veracruz de Acayo has been consistent since 2001; in Juan Venado since 2004, and in Salamina since 2008. In these three areas, monitoring is conducted through nightly patrols across the peak months of the nesting season (~October and February) (Torres and Urteaga, 2009[29]; Jarquín *et al.*, 2017[27]). Most nests are relocated to hatcheries in order to protect them from poaching and extreme environmental conditions.

Recently, the Laud OPO Network conducted a population viability analysis for the eastern Pacific population (LAUDOPO-Network, 2020[30]). Results indicate that current conservation efforts would not be sufficient to revert the extinction trend. The paper reports that in order to revert the situation to a positive population-trend in addition to current conservation projects, managers need to reduce adult mortality by at least 20%. In this scenario improving conservation efforts to reduce leatherback bycatch in the small-scale fisheries of Nicaragua is priority, particularly given the high rates of bycatch reported by Ortiz-Alvarez *et al.* (2020)[28].

4.5. Research

Between 2016 and 2021 two peer-reviewed work that included data from leatherbacks in the pacific of Nicaragua were published. Ortiz-Alvarez *et al.* (2020)[28] provide a rapid assessment of leatherback bycatch on the small-scale fisheries. LAUDOPO-Network, (2020)[30] reports result from a population viability analysis for Eastern Pacific leatherback.

Figure 1. Location of sea turtle nesting beaches in the Pacific coast of Nicaragua.

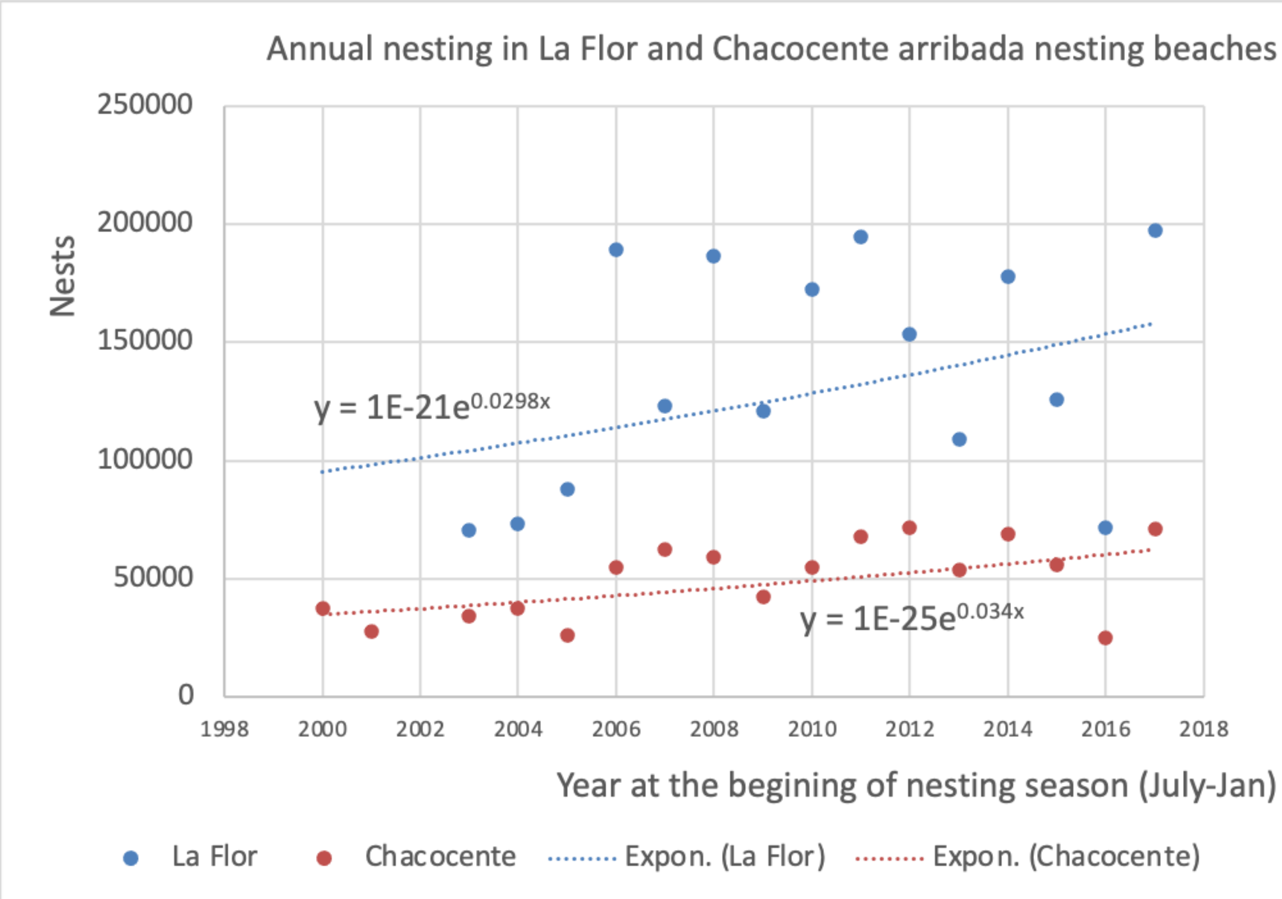

Figure 2. Nesting trend (Number of clutches/ year) in Chacocente and La Flor beach (Data source: MARENA Unpublished).

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Table 1. Biological and conservation information about sea turtle Regional Management Units in Nicaragua.

Species	*Lepidochelys olivacea*		*Dermochelys coriacea*		*Chelonia mydas*		*Eretmochelys imbricata*	
RMU	**Eastern Pacific**	**Ref #**	**Eastern Pacific**	**Ref #**	**Eastern Pacific**	**Ref #**	**Eastern Pacific**	**Ref #**
Occurrence								
Nesting sites	Y	3,29	Y	3,29	Y	3,29	Y	10,31,32
Pelagic foraging grounds	U	n/a	U	n/a	U	n/a	U	n/a
Benthic foraging grounds	U	n/a	U	n/a	U	n/a	Y	13,15
Key biological data								
Nests/yr: recent average (range of years)	194400 (2011-2016)	Table 2	45.8 (2008-2016)	Table 2	293.2 (2008-2017)	Table 2	278.67 (2012-2017)	Table 2
Nests/yr: recent order of magnitude	5	Table 2	1	Table 2	2	Table 2	2	Table 2
Number of "major" sites (>20 nests/yr AND >10 nests/km yr)	9	Table 2	1	Table 2	4	Table 2	2	Table 2
Number of "minor" sites (<20 nests/yr OR <10 nests/km yr)	~15	PS (See text)	> 3	Table 2 & See text	8	Table 2	8	Table 2
Nests/yr at "major" sites: recent average (range of years)	194400 (2011-2016)	Table 2	23.57 (2010-2012; 2016)	Table 2	234.8 (2008-2017)	Table 2	257 (2012-2017)	Table 2
Nests/yr at "minor" sites: recent average (range of years)	n/a		22.2 (2008-2016)	Table 2	58.4 (2008-2017)	Table 2	23.67 (2012-2017)	Table 2
Total length of nesting sites (km)	55.05	Table 2	37.3	Table 2	57.55	Table 2	43.05	Table 2
Nesting females / yr	U	n/a	U	n/a	U	n/a	U	n/a
Nests / female season (N)	U	n/a	U	n/a	U	n/a	U	n/a
Female remigration interval (yrs) (N)	U	n/a	U	n/a	U	n/a	U	n/a
Sex ratio: Hatchlings (F / Tot) (N)	U	n/a	U	n/a	U	n/a	U	n/a
Sex ratio: Immatures (F / Tot) (N)	U	n/a	U	n/a	U	n/a	U	n/a
Sex ratio: Adults (F / Tot) (N)	U	n/a	U	n/a	U	n/a	U	n/a
Min adult size, CCL (cm)	56.3-62.9	Table 2	127.1-132.8	Table 2	72.5-86	Table 2	69.95-70.1	Table 2
Age at maturity (yrs)	U	n/a	U	n/a	U	n/a	U	n/a
Clutch size (n eggs) (N)	85.0 - 95	Table 2	51-64	Table 2	71-81	Table 2	150.9-151.4	Table 2
Emergence success (hatchlings/egg) (N)	0.063 - 0.847	Table 2	13-50.33	Table 2	0.615-0.75	Table 2	60.1-67.21	Table 2

Species	*Lepidochelys olivacea*		*Dermochelys coriacea*		*Chelonia mydas*		*Eretmochelys imbricata*	
RMU	**Eastern Pacific**	**Ref #**	**Eastern Pacific**	**Ref #**	**Eastern Pacific**	**Ref #**	**Eastern Pacific**	**Ref #**
Nesting success (Nests/ Tot emergence tracks) (N)	n/a		n/a		n/a		n/a	
Trends								
Recent trends (last 20 yrs) at nesting sites (range of years)	Up (2000-2016)	29, PS	Down (2002-2017)	23	U	n/a	U	n/a
Recent trends (last 20 yrs) at foraging grounds (range of years)	U	n/a	U	n/a	U	n/a	U	n/a
Oldest documented abundance: nests/yr (range of years)	U	n/a	U	n/a	U	n/a	U	n/a
Published studies								
Growth rates	N		N		N		N	
Genetics	N		N		N		Y	14,33
Stocks defined by genetic markers	Y	7,8	N		N		Y	16,33
Remote tracking (satellite or other)	N		N		Y	34	Y	13
Survival rates	N		N		N		N	
Population dynamics	N		N		N		Y	10
Foraging ecology (diet or isotopes)	N		N		N		Y	Unpublished
Capture-Mark-Recapture	N		N		N		Y	10
Threats								
Bycatch: presence of small scale / artisanal fisheries?	Y	3	Y	3,23,28	Y	3	Y	15
Bycatch: presence of industrial fisheries?	Y	n/a	Y	n/a	Y	n/a	Y	n/a
Bycatch: quantified?	N	n/a	Y	28	N	n/a	Y	15
Take. Intentional killing or exploitation of turtles	Y	3	N	n/a	n/a	n/a	N	n/a
Take. Egg poaching	Y	3,5	Y	3,23	Y	2,3	Y	Table 2

Species	*Lepidochelys olivacea*		*Dermochelys coriacea*		*Chelonia mydas*		*Eretmochelys imbricata*	
RMU	**Eastern Pacific**	**Ref #**	**Eastern Pacific**	**Ref #**	**Eastern Pacific**	**Ref #**	**Eastern Pacific**	**Ref #**
Coastal Development. Nesting habitat degradation	Y	3	Y	3,23	U	n/a	U	n/a
Coastal Development. Photopollution	U		U		U		U	
Coastal Development. Boat strikes	U		U		U		U	
Egg predation	Y	3	N	23	U		U	
Pollution (debris, chemical)	U		U		U		U	
Pathogens	Y	9	U		U		U	
Climate change	U		U		U		U	
Foraging habitat degradation	U		U		U		U	
Other	U		U		U		U	
Long-term projects								
Monitoring at nesting sites	Y	3	Y	3,23	Y	2,3	Y	11
Number of index nesting sites	2	PS	2	3,23	2	2	2	11,12
Monitoring at foraging sites	N		N		N		Y	unpublished
Conservation								
Protection under national law	Y	3	Y	3	Y	3	Y	3
Number of protected nesting sites (habitat preservation)	5	See text	2	3	4	2,3,35	1	2,11,36
Number of Marine Areas with mitigation of threats	n/a		n/a		n/a		1	2,11,36
Long-term conservation projects (number)	5	See text	1	23	1	2	2	2,11,36
In-situ nest protection (e.g. cages)	Y	n/a	N	23	Y	2	Y	2,11,36
Hatcheries	Y	n/a	Y	23	Y	2,35	Y	2,11,36
Head-starting	N	n/a	N	n/a	N		N	
By-catch: fishing gear modifications (eg, TED, circle hooks)	Y	3	Y	3	Y	3	Y	3
By-catch: onboard best practices	N	n/a	N	n/a	N		Y	15
By-catch: spatio-temporal closures/reduction	Y	3	Y	3	Y	3	Y	3

Species	*Lepidochelys olivacea*		*Dermochelys coriacea*		*Chelonia mydas*		*Eretmochelys imbricata*	
RMU	**Eastern Pacific**	**Ref #**	**Eastern Pacific**	**Ref #**	**Eastern Pacific**	**Ref #**	**Eastern Pacific**	**Ref #**
Other	n/a		n/a		n/a		n/a	

Table 2. Sea turtle nesting beaches in Nicaragua.

RMU / Nesting beach name	Index site	Nests/yr: recent average (range of years)	Crawls/yr: recent average (range of years)	Central point		Length (km)	% Monitored	Reference #	Monitoring Level (1-2)	Monitoring Protocol (A-F)	Average protection (%)	Average minimun CCL/ season (cm)	Average clucth size / season	Average % hatch succes /season	Average Monitoring season (Start date - En date)	renesting (clotches/female) Range-seanon	remigration (Yrs)
				Long	Lat												
Eastern Pacific																	
Lepidochelys olivacea																	
Ostional*	**N**	**73.5 (2014-2015)**	**n/a**	**-85.760102**	**11.1061934**	**1.5**	**n/a**	**2**	**2**							**n/a**	**n/a**
Guacalito	**N**	**0.5 (2014-2015)**	**n/a**	**-85.780233**	**11.1168017**	**0.3**	**100**	**2**	**1**	**B**					**Jan-Dec**	**n/a**	**n/a**
Holman	**N**	**2 (2012-2013)**	**n/a**	**-85.791256**	**11.1219951**	**0.8**	**100**	**34**	**1**	**B**					**Jun-Jan**	**n/a**	**n/a**
La Flor	**Y**	**136014 (2011-2016)**	**n/a**	**-85.794111**	**11.1411914**	**1**	**100**	**29**	**1**	**B**	**n/a**	**n/a**	**95**	**6.3**	**(1-Jul/ 31-Jan)**	**n/a**	**n/a**
Brasilon	**N**	**21.3 (2013-2015)**	**n/a**	**-85.799881**	**11.1488905**	**0.35**	**100**	**2**	**1**	**B**	**87**				**Jan-Dec**	**n/a**	**n/a**
El Coco*	**N**	**173.5 (2014-2015)**	**n/a**	**-85.802231**	**11.1565514**	**0.8**	**n/a**	**2**	**2**							**n/a**	**n/a**
Escondida	**N**	**28.7 (2013-2015)**	**n/a**	**-86.122241**	**11.4685332**	**0.5**	**100**	**2**	**1**	**B**				**76.3**	**Jan-Dec**	**n/a**	**n/a**
Redonda	**N**	**16 (2015)**	**23 (2015)**	**-86.030871**	**11.3831646**	**0.3**	**100**	**2**	**1**	**B**					**Jan-Dec**	**n/a**	**n/a**
Chacocente	**Y**	**57408 (2011-2016)**	**n/a**	**-86.185705**	**11.5247674**	**1.5**	**100**	**29,37**	**1**	**B**	**n/a**	**n/a**	**95**	**16**	**(1-Jul/ 31-Jan)**	**n/a**	**n/a**
Veracruz de Acayo	**N**	**267 (2010-2016)**	**326 (2010-2016)**	**-86.250833**	**11.5772222**	**5.5**	**100**	**23,26,38–42**	**2**	**D**	**23.3**	**57.9**	**86**	**68.57**	**(28-Oct / 23-Mar)**	**n/a**	**n/a**

RMU / Nesting beach name	Index site	Nests/yr: recent average (range of years)	Crawls/yr: recent average (range of years)	Central point		Length (km)	% Monitored	Reference #	Monitoring Level (1-2)	Monitoring Protocol (A-F)	Average protection (%)	Average minimun CCL/ season (cm)	Average clutch size / season	Average % hatch succes /season	Average Monitoring season (Start date - En date)	renesting (clotches/female) Range-seanon	remigration (Yrs)
				Long	Lat												
Salamina	**N**	**376 (2010-2016)**	**387 (2010-2012; 2016)**	**- 86.653611**	**11.9775**	**9**	**100**	**27,43–48**	**2**		**25.7**	**56.3**	**87.1**	**73.14**	**(24-Oct/1-Apr)**	**n/a**	**n/a**
Juan Venado	**N**	**530 (2008)**	**n/a**	**- 86.944221**	**12.3090021**	**22**	**100**	**29**	**2**							**n/a**	**n/a**
Estero Padre Ramos	**Y**	**19.5 (2012-2017)**	**20.14 (2012-2017)**	**- 87.484436**	**12.7751389**	**12**	**100**	**11,31,35,38,49,50**	**2**		**84.62**	**62.9**	**85**	**84.65**	**(2-May/30-Sep)**	**n/a**	**n/a**
Eastern Pacific *Dermochelys coriacea*																	
El Coco*	**N**	**1.5 (2014-2015)**	**n/a**	**- 85.802075**	**11.1568126**	**0.8**	**n/a**	**2**	**2**				**64**	**13**			
Veracruz de Acayo	**Y**	**9.7 (2010-2016)**	**10.5 (2010-2016)**	**- 85.802231**	**11.1565514**	**5.5**	**100**	**23,26,38–42**	**1**	**B**	**76**	**127.1**	**51**	**50.33**	**(28-Oct / 23-March)**	**7 to 11**	**2 to 5**
Salamina	**Y**	**23.57 (2010-2016)**	**23.95 (2010-2016)**	**- 86.653611**	**11.9775**	**9**	**100**	**27,43–48**	**1**	**B**	**94**	**132.8**	**58.5**	**31**	**(24-Oct/1-Apr)**	**8 to 12**	**2**
Juan Venado	**N**	**11 (2008)**	**n/a**	**- 86.944221**	**12.3090021**	**22**	**100**	**29**	**1**	**B**					**(25-Jul/31-Jan)**		
Eastern Pacific *Chelonia mydas*																	
Ostional*	**N**	**5 (2014-2015)**	**n/a**	**- 85.760102**	**11.1061934**	**1.5**	**n/a**	**2**	**2**								
Guacalito	**Y**	**16.5 (2014-2015)**	**n/a**	**- 85.780233**	**11.1168017**	**0.3**	**100**	**2**	**1**	**B**	**93.9**				**Jan-Dec**		
Holman	**N**	**1 (2012-2013)**	**n/a**	**- 85.791256**	**11.1219951**	**0.8**	**100**	**34**	**1**	**B**							
Brasilon	**Y**	**108 (2013-2015)**	**n/a**	**- 85.799881**	**11.1488905**	**0.35**	**100**	**2**	**1**	**B**	**87**				**Jan-Dec**		
El Coco*	**N**	**29.5 (2014-2015)**	**n/a**	**- 85.802231**	**11.1565514**	**0.8**	**n/a**	**2**	**2**								
Escondida	**Y**	**74.3**	**n/a**	**-**	**11.4685332**	**0.5**	**100**	**2**	**1**	**B**				**75**	**Jan-Dec**		

RMU / Nesting beach name	Index site	Nests/yr: recent average (range of years)	Crawls/yr: recent average (range of years)	Central point		Length (km)	% Monitored	Reference #	Monitoring Level (1-2)	Monitoring Protocol (A-F)	Average protection (%)	Average minimun CCL/ season (cm)	Average clucth size / season	Average % hatch succes /season	Average Monitoring season (Start date - En date)	renesting (clotches/female) Range-seanon	remigration (Yrs)
				Long	Lat												
		(2013-2015)		86.122241													
Redonda	N	23 (2015)	26 (2015)	- 86.030871	11.3831646	0.3	100	2	1	B					Jan-Dec		
Veracruz de Acayo	N	13.4 (2010-2016)	20.9 (2010-2016)	- 86.250833	11.5772222	5.5	100	23,26,38–42	1	B	90.4	86	71	63.52	(28-Oct / 23-Mar)	NA	NA
Salamina	N	3.5 (2010-2016)	3.5 (2010-2016)	- 86.653611	11.9775	9	100	27,43–48	1	B	100	72.5	75.7	61.49	(24-Oct/1-Apr)	NA	NA
Juan Venado	N	4 (2008)	n/a	- 86.944221	12.3090021	22	100	29	1	D							
Aserradores	N	8 (2014-2017)	15.7 (2014-2017)	- 87.343611	12.6158333	4.5	100	32,36,51	2		96.9	84.25	75	63.17	(16-May/16-Sep)	NA	NA
Estero Padre Ramos	N	7 (2012-2017)	9.9 (2012-2017)	- 87.484436	12.7751389	12	100	11,31,35,38,49,50	2		79.5	79.5	81	71.06	(2-May/30-Sep)	NA	NA
Eastern Pacific *Eretmochelys imbricata*																	
Ostional*	N	5 (2014-2015)	n/a	- 85.760102	11.1061934	1.5		31	2								
Guacalito	N	1.5 (2014-2015)	n/a	- 85.780233	11.1168017	0.3	100	31	1	B	75				Jan-Dec		
Holman	N	1 (2012-2013)	n/a	- 85.791256	11.1219951	0.8	100	34	1	D							
Brasilon	N	0.67 (2013-2015)	n/a	- 85.799841	11.1486774	0.35	100	31	1	B	87				Jan-Dec		
El Coco*	N	3.5 (2014-2015)	n/a	- 85.802075	11.1568126	0.8	100	31	2				149.4	36.3			
Escondida	N	2 (2013-2015)	n/a	- 86.122241	11.4685332	0.5	100	31	1	B				75.00	Jan-Dec		
Redonda	N	8 (2015)	9 (2015)	- 86.030871	11.3831646	0.3	100	31	1	B					Jan-Dec		
Juan Venado	N	1 (2008)	n/a	- 86.944221	12.3090021	22	100	29	1	D							

RMU / Nesting beach name	Index site	Nests/yr: recent average (range of years)	Crawls/yr: recent average (range of years)	Central point		Length (km)	% Monitored	Reference #	Monitoring Level (1-2)	Monitoring Protocol (A-F)	Average protection (%)	Average minimun CCL/ season (cm)	Average clutch size / season	Average % hatch succes /season	Average Monitoring season (Start date - En date)	renesting (clotches/female) Range-seanon	remigration (Yrs)
				Long	Lat												
Aserradores	Y	70 (2014-2017)	127.3 (2014-2017)	-87.343611	12.6158333	4.5	100	32,36,51	1	B	86.2	69.95	150.9	67.21	(16-May/16-Sep)		1.8
Estero Padre Ramos	Y	187 (2012-2017)	222.6 (2012-2017)	-87.484436	12.7751389	12	100	11,31,35,38,49,50	1	B	96.3	70.1	151.4	60.1	(2-May/30-Sep)		2.3

Table 3. International conventions protecting sea turtles and signed by Nicaragua.

International Conventions	Signed	Binding	Compliance measured and reported	Species	Conservation actions	Relevance to sea turtles
Convention on Biological Diversity (CBD)	Y (1995)	-	Yes (43)	all	Sea Turtle Conservation Plan in La Flor and Chacocente Wildlife Refuges and the Natural Reserve Isla Juan Venado	Umbrella for sea turtle and habitat protection
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	Y (1977)	Y	Yes	all	It restricts the international trade of sea turtle sub products.	Protect turtles, through banning international trade of products or sub-products
Ramsar	Y (1997)	Y	n/a	all	This convention binds the country to the sustainable management and protection of critical habitat for sea turtles such as nesting beaches, mangroves and coral reef	International legal framework binding the parts to protect habitat and the sea turtles
Inter-American Convention for The Protection and Conservation of Sea Turtles (CIT)	No		n/a	all	Nicaragua has not signed this convention	International legal framework binding the parts to protect habitat and the sea turtles. Key for coordination of conservation plans at the level of population. Facilitate information and knowledge sharing across the parts

Table 4. Projects and databases on sea turtles in Nicaragua.

Organization coordinating field work	Organization type	Primary species	Primary beaches	Long-term (>5 consecutive years)
MARENA	**Government**	**Lo**	**La Flor**	**Y**
MARENA	**Government**	**Lo**	**Chacocente**	**Y**
Paso Pacífico	**NGO**	**Cm, Lo**	**Ostional**	**U**
Paso Pacífico	**NGO**	**Lo**	**Guacalito**	**Y**
Paso Pacífico	**NGO**	**Lo**	**Holman**	**Y**
Paso Pacífico	**NGO**	**Cm**	**Brasilon**	**Y**
Paso Pacífico/ Parque Marítimo El Coco	**NGO / Private***	**Lo, Cm**	**El Coco**	**Y**
Paso Pacífico	**NGO**	**Cm**	**Escondida**	**U**
Paso Pacífico	**NGO**	**Cm**	**Redonda**	**U**
Fauna & Flora International	**NGO**	**Dc**	**Veracruz de Acayo**	**Y**
Fauna & Flora International	**NGO**	**Dc**	**Salamina**	**Y**
Fauna & Flora International / Comite Carey	**NGO / Community**	**Ei**	**Reserva Natural Estero Padre Ramos**	**Y**
Fauna & Flora International / Marina Puesta del Sol	**NGO / Private**	**Ei**	**Aserradores**	**N**
Los Cardones Ecolodge	**Private**	**Lo**	**Los Cardones**	**Y**
Proyecto Casa Madera	**Private**	**Lo**	**Maderas**	**U**
Resort Mujul	**Private**	**Lo**	**Guacalito de la Isla; Mansanillo**	**U**
Proyecto Cooperativa	**Community/Private**	**Lo**	**Santana**	**U**
Hotel Punta Teonoste	**Private**	**Lo**	**Punta Teonoste**	**Y**
Gran Pacifica	**Private**	**Lo**	**San Juan**	**Y**
Rigo's House	**Private**	**Lo**	**Salinas Grandes**	**U**
UNAN Leon	**University**	**Lo, Dc**	**Salinas Grandes**	**Y**
Proyecto Palo de Oro/ UNAN León / FFI	**Private / Academic /NGO**	**Lo, Dc**	**Juan Venado**	**Y**
Estrella del Pacífico	**U**	**Lo**	**Poneloya**	**Y**
Surfing Turtle Lodge	**Private**	**Lo**	**Los Brasiles**	**?**
Coco loco -proyecto comunidad	**Private / community**	**Lo**	**Maria del Mar, Manzano 1**	**Y**
Sea Joy- Aquaculture	**Private**	**Lo**	**Jiquilillo**	**Y**
El Proyecto de Arturo	**NGO / Community**	**Lo**	**Los Zorros**	**?**
El Proyecto de Rob	**Private**	**Lo**	**Los Zorros**	**?**
Monty's Surf Ranch	**Private**	**Lo**	**Venecia, RN Padre Ramos**	**?**
Redwood resort	**Private**	**Lo**	**Mechapa**	**?**

Lo: *Lepidochelys olivacea*, Cm: *Chelonia mydas*; Ei: *Eretmochelys imbricata*, Dc: *Dermochelys coriacea*
U: unknown information
* Private refers to business or non-organized individuals

Costa Rica

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General remarks

Costa Rica has been making efforts to improve its ecological representativeness, and precisely one of the conservation objects due to its hazards is the marine turtles. Four species are frequently observed in national waters and lay their eggs on our beaches, the leatherback turtle (*Dermochelys coriacea*), the olive ridley (*Lepidochelys olivacea*), the green (Caribbean) or black (Pacific) (*Chelonia mydas*), and the hawksbill turtle (*Eretmochelys imbricata*). Loggerhead turtles (*Caretta caretta*) had been nesting on Caribbean beaches, but this is not a frequent activity.

Although there is still a lot of work to be done on marine conservation, the country already has different management categories that help complement the efforts being made in sea turtle conservation and protection. Up today, there are 22 marine areas with mitigation of threats in the Pacific side of Costa Rica: five National Wildlife Refuges with a marine portion; five National Parks with marine extensions; two Marine Management Areas, and ten marine responsible fishing areas (Fig. 1a,1b).

In 2018, Costa Rica formalized its National Strategy for the Conservation and Protection of sea turtles to improve the management over the following ten years. Its vision is focused on developing management within and outside protected areas under alternative governance models for the generation of well-being, based on management, research, education, and ecotourism programs, with the participation of the State, civil society, non-governmental organizations, government, the academy, and the private sector (31).

In Costa Rica, non-governmental organizations and academic as well as government institutions make their possible contributions each year, investing time and resources to investigate and protect sea turtles that arrive at the country to nest on their beaches or use foraging areas. Thus, many monitoring and research programs have been consolidated over the years, whereas others are currently developed along the coast of Costa Rica (see Table 4). Research and conservation of sea turtles have not only increased our knowledge about the biology of turtles over time but have also provided scientists with a piece of important information to evaluate the population status of these species at a regional level and, thereby, consider and implement the most effective conservation measures.

Today, there is an enormous effort to monitor and/or tag sea turtles on almost all the nesting beaches of the country, both within and outside the protected areas, providing information about population trends about the species of sea turtles presents in the Pacific side of Costa Rica. Most of these projects also evaluate the success of egg incubation and the possible factors that affect it. These have allowed the Costa Rican State, through the National System of Conservation Areas (SINAC) of the Ministry of Environment and Energy (MINAE), register for the Pacific side of Costa Rica, at least 70 nesting sites for sea turtles (Fig. 2) and several foraging sites (Fig. 5). Of those 70 sites, 40% (n = 28) are within Protected Wildlife Areas (ASP, acronym in Spanish) and 60% (n = 42) outside Protected Wildlife Areas (FASP, acronym in Spanish).

The information compiled to prepare this report corresponds only to data available for 37 nesting beaches. In these sites, there is a consolidated monitoring program or in the process of being consolidated. This group includes index beaches by species, which have been reported to the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC) through the national report (32).

To date, COVID 19 has had a significant negative impact on the operation and economic sustainability of the monitoring and research programs for sea turtles in the country. Since April 2020, the Costa Rican government has been considering and implementing measures to contain the spread of the disease. The entry of people to the beaches of the entire country, including the nesting sites of sea turtles, was not allowed by the authorities, keeping access closed for an extended period of at least eight months, affecting the registry of information on sea turtles. The information record has been much lower concerning previous years, so the data reported for 2020 are not a reflection of the reality of sea turtle nesting in the country.

1. RMU: Green turtle (*Chelonia mydas*) – Eastern Pacific

1.1. Distribution, abundance, trends

1.1.1. Nesting sites

Along the Pacific coast of Costa Rica, as of 2020, 41 sites have been reported in which black turtle nesting occurs (Fig. 3), 18 of them are in protected wildlife areas, and 23 sites are outside protected wildlife areas. For this report, the information was compiled for 24 of the sites (50.3 km of beach length), and 17 of which have been permanently monitored over a period longer than five years, four sites are under some category of state protection and represent only 32,4% of the annual average number of nests reported in this report (see Table 1 and Table 2).

The green turtle is one of the most studied sea turtles in the world. However, scientific information published on the species in the Pacific of Costa Rica has been scarce. Richard and Hughes (1972) and Cornelius (1976) were the first to report the nesting of the black turtle. It is in recent years that the importance of Costa Rican beaches for black turtle nesting has become more consistently known, as demonstrated in the published works of Drake et. al. (2003); Blanco et. al. (2011 and 2012a); Santidrian-Tomillo et. al. (2014); Ureña López (2014); Dutton et. al. (2014); Fonseca et. al. (2018); Santidrian-Tomillo et al. (2019); Valverde-Cantillo et. al. (2019); Ramírez et. al. (2021) and Seminoff et. al. (2021).

Monitoring and research programs have been consolidated over the years. It has allowed the registration and systematization of the information and, to some extent, its socialization. Although many of the projects still need to publish their results beyond the annual reports, they must submit to the state authorities.

Recent data about numbers of nests and nesting females on three of the index beaches (Isla San José, Cabuyal, and Nombre de Jesús) (Fig 4), position the North Pacific of Costa Rica as the most relevant nesting area for this species in the Central American isthmus (10,12). Although the number of years of monitoring does not allow us to determine a robust population trend for black turtles in Costa Rica, it is important to be attentive to understand the conditions why the number of nests and females has been decreasing in the last four years to consider possible conservation measures.

The population of black turtles is recently monitored in Costa Rica. However, it is very interesting and important for its conservation to knowing that according to Dutton et. al. (2014), the population is genetically closely related to the Galápagos. They also argued that the presence of ancient endemic haplotypes suggests that the area was not recently colonized and shows signs of a population that remained stable for a long period. Therefore, the recent nesting data observed in Figure 4 may be evidence of a population shift that should be considered for possible attention through conservation measures, particularly as nesting numbers in the Galapagos appear to be declining (12).

1.1.2. Marine areas

By now, the available information on feeding areas and migratory routes of green turtles in Costa Rica is very limited. This is especially because the greatest research and conservation efforts have been concentrated mainly on nesting ecology, identification of females, and protection of their nests. In recent years, at least seven important foraging areas have been identified for black turtles in the Costa Rican Pacific, and the released information has been very relevant to consider into the conservation efforts that will be developed. These marine areas are Golfo Dulce (10) (Fig. 5a); Cocos Island (62); Gulf of Papagayo (6) (Fig. 5b): Santa Elena Bay (6) (Fig. 5b); adjacent Matapalito Bay and rather sporadic or stop-over sites such as Coyote and Cabo Blanco (26, 28) (Fig. 5c).

In the Golfo Dulce, classified as a responsible marine fishing area (Fig. 1b), the availability of food is high throughout the year, so it is not surprising that this has been determined as an important habitat for adult green turtles (10). Other relevant information is that the turtles that were captured and tagged in Golfo Dulce have not yet been reported nesting on Costa Rican beaches, nor have they been found dead or incidentally captured, so the origin of the individuals is unknown (10). However, recently in Golfo Dulce there have been registered females that were tagged at Nombre de Jesús beach in Costa Rica and two turtles with tags from Quinta Playa, Isla Isabela Galapagos Islands, which reinforces the importance of the Gulf as a feeding habitat for green turtles regionally. Matapalito and Santa Elena Bay, on the other hand, host green turtle populations of distinct natal origins (26), including from the largest regional nesting rookery found in Colola, Mexico (28).

Satellite information has shown that green turtles from Mexico and Galapagos migrate to foraging areas in Central America (23), and according to Dutton et. al. (2014), the Costa Rican turtle population is the product of multiple colonization pathways from ancient individuals in the Central Pacific (Hawaii) and more recent immigrations from the Galapagos and Mexican colonies. Green turtles tagged in Galapagos have been recorded nesting on Costa Rica's Pacific beaches (6), as well as foraging in the Golfo Dulce (10).

Further north, at playa Nombre de Jesús, an important finding of the green turtle population was discovered. During inter-nesting periods, females stay most of the time near the nesting beach (5) and once their egg-laying phase is over, some remain resident in the Gulf of Papagayo and Gulf of Santa Elena, remaining in the region during the non-reproductive phases (6,23).

Other interesting information to be considered is that in the foraging sites for the green turtle, Punta Coyote, and Cabo Blanco, juvenile individuals of green turtle predominated with sizes close to adult sizes, which could represent a habitat dominated by subadults close to maturity (26).

The migratory movements of the green turtles showed at least three different migratory strategies. The first one corresponds to turtles that migrated to waters off the coast of Nicaragua, El Salvador, and Guatemala. The second strategy refers to turtles that moved to Panama and a third, very important for the country, corresponds to a population that remains resident near its nesting beach (6).

All of the above represents a great responsibility and demonstrates that green turtles use marine corridors near the coast to move between nesting sites and feeding sites found in the country and in the Central American isthmus region (6), where interaction occurs between the individuals who congregate, even if they come from different places located at great distances.

1.2. Other biological data

Table 1 shows a summary of important biological and conservation information about sea turtle species in the Costa Rican Pacific.

1.3. Threats

1.3.1. Nesting areas

Table 1 shows the threats that are still affecting the green turtles in the Pacific of Costa Rica. As is the case for all sea turtle species, egg poaching is one of the highest impacts and occurs mainly on nesting beaches outside protected areas. It has been estimated that at the Nombre de Jesús beach complex, one of the most important sites in the Pacific of Costa Rica (694 nests/year), egg extraction was over 90% before 2006. To date, this percentage of extraction is estimated at 10% (unpublished data) since the presence of Kuemar Association personnel is maintained most of the year, and relocation of nests is done on the same beach. Despite this, the activity of egg poaching has not yet been eradicated.

In other important places such as Cabuyal, Los Pargos, and Matapalo, egg poaching is still present and decreases during periods of time when there is staff working on the beaches.

High visitation of tourists without beach access control is another threat that begins to be relevant on nesting beaches outside protected areas. In wildlife protected areas, the entry of visitors for the observation of sea turtles is controlled through a legal instrument known as 'regulation of public use'. Nonetheless, outside protected areas, these prevention tools do not exist, and some tourist activities are carried out without applying good practices. For example, many tourists around a turtle for the observation can cause a negative impact on them. Some just return to the sea, and others even stop their egg-laying process. However, it is relevant to mention that among the sanitary measures implemented by the government to reduce the risk of contagion by COVID 19, the closing of people's access to all the country's beaches decreased the impact of tourist visitation threat to turtle nesting.

Coastal development that does not include risk analysis and impact mitigation measures for critical sea turtle habitats in its design continues to be a threat that concerns those responsible for coordinating monitoring and research programs and SINAC. However, this concern requires working on governance models for these sites, which requires the participation of all key actors. This is the line of action that is being worked on.

The reproductive success of sea turtles depends largely on the stability of the nesting beaches, and that good hatching and hatchlings' emergence successes occur. In the ocean, good conditions of productivity must exist, which favor the food and energy necessary for them to migrate and lay their eggs on the nesting beaches. The sensitivity of marine turtles to climatic variability is remarkable and makes it essential to consider the impacts of climate change in their national and regional recovery plans.

Costa Rica has recognized that the effects of climate change impact sea turtle nesting and feeding habitats. So that, in some of its beaches will be implemented the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC) project, called "Pilot Project for IAC Party Countries for the collection of environmental parameters of their nesting index beaches", for a continuous period of 5 years. It is based on the Resolution of Adaptation of sea turtle habitats to climate change CIT-COP4-2009-R5 (http://www.iacseaturtle.org/docs/resolucionesCOP4CIT/CIT-COP4-2009-R5ESP_Final.pdf).

1.3.2. Nesting areas

The fact that green turtles are concentrating in areas near nesting beaches, that use marine corridors near the coast to move towards feeding sites, and that some of these sites are in jurisdictional waters makes them vulnerable to anthropogenic activities impact such as incidental capture by fishing.

Longline fishing is an activity that is carried out in a large geographic area of the country, where some 350 vessels are active. Recent information on sea turtle interaction with pelagic longline fisheries is very limited. Between November 2007 and May 2008, bycatch of 256 sea turtles was reported. Bycatch by the longline fleet, the use of live bait, poor handling of those turtles caught, and the high concentration of hooks deployed near nesting beaches generate high mortality (30).

In addition to that, an increase in extreme El Niño events could severely compromise green turtle populations. Low oceanic productivity would influence migration intervals, these being longer and showing a higher interannual variability in the nesting numbers, being low after the ENSO events. The viability of green turtle populations could decrease if the reproductive frequency is having reduced due to poor feeding conditions influenced by climate change (40).

1.4. Conservation

From the 41 sites where green turtles are nesting, 18 of them are protecting by some category of state management, National Wildlife Refuge, or National Park. On 24 beaches, includes in this report, there are a monitoring and research program of sea turtles, in which the protection of females and nests are carried out. Twelve are the marine areas under the administration of SINAC, that were created for conservation, and ten are the Responsible fishing marine areas created under the administration of the National Fisheries Institute. The green turtles could eventually move through these spaces (Fig.1a,1b).

The country has ratified nine international treaties (see Table 3) and at least 30 national legal instruments (1), which are directly related to the conservation and protection of sea turtles.

Sea turtle monitoring programs carry out protection and conservation activities for females, nests, and, to the extent of their competencies and possibilities, for the current habitats (see Table 4). The nesting beaches in protected areas have the strength to be under the protection of a specific law, a Management Plan, and a Regulation for Public Use. However, nesting beaches and marine spaces outside protected areas are at high risk to anthropogenic threats, so it is urgent to define and implement governance models that ensure the conservation of the habitat, the species, and human well-being.

1.5. Research

1. Evaluate the impact of different types of fisheries on foraging habitat, inter-nesting, and spaces where sea turtle movement occurs, identifying those areas of greatest interaction.

2. Promote research techniques to reduce incidental capture of sea turtles.

3. Learn about the impacts of marine debris on sea turtles (including ingestion of plastics, ghost fishing gear, microplastics).

4. Impacts of climate change on sea turtle nesting and its critical habitats.

2. RMU: Hawksbill turtle (*Eretmochelys imbricata*), Eastern Pacific

2.1. Distribution, abundance, trends

2.1.1. Nesting sites

The information published on hawksbill turtles in the Pacific of Costa Rica is very scarce (see Table 1). The nesting of this species is reported as sporadic in 15 sites of the Pacific coast (Fig. 6), 8 of them are in protected wildlife areas and 7 outside protected areas. For this report, information is recording from 6 sites, three of them are foraging areas, and three are nesting beaches.

Historical data cites that between January 1982 to May 2009, only 48 individuals were observed nesting in Costa Rica (51). For the period comprised between 2016-2018 in Playa Rajada, and between 2014- 2020 in complex beaches San Miguel - Costa de Oro - Bejuco, all of them in the North Pacific, only 3 and 1 nests per year, respectively, were reported (see Table 2). According to Chacón-Chaverri et. al., (2014b), less than 25 nests per year were reported on the South Pacific coast. However, in 2019 and 2020, Playa Platanares recorded 40 hawksbill nests (see table 2). This information demonstrates the vulnerability of the species in the Costa Rican Pacific.

2.1.2. Marine areas

Information on feeding sites or aggregation of hawksbill turtles is also scarce in the country, although it is higher than what is published on nesting beaches. In recent years, at least five important foraging areas have been identified for juvenile, subadult and adult individuals of the hawksbill turtle in the Costa Rican Pacific. This information is very relevant to be considered in conservation efforts that have been developed. These marine areas are: Golfo Dulce (9); Cabo Blanco (26); Punta Coyote (8); Punta Pargos (9, 26) and Bahía Matapalito (26) (Fig. 5).

Unlike the low numbers of nesting females registered on nesting beaches, Chacón-Chaverri et. al. (2014b) reported a catch of 62 individuals in the Golfo Dulce for 2010-2013. An important fact is that the highest number of captures occurred when the greatest sampling effort was made. At this aggregation site, the individuals captured were mostly adults and probably feed on macro and micro invertebrates associated with seagrasses present in the Gulf.

A different situation was presented at Punta Coyote, where most of the individuals captured were juveniles and many of small sizes, which suggests that it is a recruitment site (8). On the other hand, between 2010 and 2013, Heidemeyer et. al. (2014) captured a total of 28 individuals in the sampling sites of their study, in this case, all were juveniles (Fig. 5c). According to the available information, the hawksbill turtles confirm fidelity to the Punta Coyote and Golfo Dulce sites, while Matapalito Bay seems to be an important site for its development.

In a more recent period, 2014-2018, 203 individuals, including adults and juveniles, were reported for the Golfo Dulce area. Meanwhile, for the period 2016-2017, 28 juveniles were counted in Matapalito Bay. For the Cabo Blanco site, 23 juveniles are reporting for the period from 2017 to 2020.

2.2. Other biological data

Table 1 shows a summary of important biological and conservation information about sea turtle species in the Costa Rican Pacific.

2.3. Threats

2.3.1. Nesting sites

Table 1 shows the threats that are still affecting hawksbill turtles in the Pacific of Costa Rica. As it happens for all species of sea turtles, egg poaching, climate change, pollution, coastal development without control, are present threats on the Costa Rican Pacific coast.

A threat that persists in the region is the furtive capture for the use of the shell, making crafts for commercial purposes. Although in the Pacific of Costa Rica it is not common to capture the species for these purposes, the craft trade does occur.

Costa Rica was historically an important market for the tortoiseshell trade; however, the most recent data seems to indicate a significant decline of this market in the country. In 2017, about 20 percent of souvenir stores surveyed in different areas of the country sold tortoiseshell products. In recent surveys, less than 7 percent of commercial establishments kept products for sale. While this is not definitive evidence of a decline, as none of the more recent surveys are comprehensive, the data indicate that the trade-in Costa Rica has been greatly reduced from previous levels due to increased law enforcement (34).

2.3.2. Marine areas

Bycatch remains one of the major threats to the conservation of hawksbill in the Tropical Eastern Pacific. However, published and recent information regarding the impact of fisheries on the populations of sea turtles is scarce.

2.4. Conservation

Of the 15 sites where hawksbill turtles have been recorded, 8 of them are protected under a government management category (National Wildlife Refuge or National Park). In 6 sites, 3 of which are nesting beaches and 3 are foraging sites, a monitoring and research program is implemented.

Twelve are marine areas under the administration of SINAC, were created for conservation, and ten are responsible fishing marine areas created under the administration of the National Fisheries Institute. Through these areas, hawksbill turtles could eventually move (Fig.1a, 1b).

The country has ratified nine international treaties (see Table 3) and at least 30 national legal instruments (1), which are directly related to the conservation and protection of sea turtles.

Sea turtle monitoring programs carry out protection and conservation activities for females, nests, and, to the extent of their competencies and possibilities, for the current habitats (see Table 4). The nesting beaches in protected areas have the strength to be under the protection of a specific law, a Management Plan, and a Regulation for Public Use. However, nesting beaches and marine spaces outside protected areas are at high risk to anthropogenic threats, so it is urgent to define and implement governance models that ensure the conservation of the habitat, the species, and human well-being.

2.5. Research

1. Evaluate the impact of different types of fisheries on foraging habitat, inter-nesting, and spaces where sea turtle movement occurs, identifying those areas of greatest interaction.

2. Promote research on techniques to reduce the incidental capture of sea turtles.

3. Learn about the impacts of marine debris on sea turtles (including ingestion of plastics, ghost fishing gear, microplastics).

4. Impacts of climate change on sea turtle nesting and its critical habitats.

3. RMU: Olive ridley (*Lepidochelys olivacea*) – Eastern Pacific

3.1. Distribution, abundance, trends

3.1.1. Nesting sites

In the Pacific of Costa Rica, the nesting of Lepidochelys olivacea is reported in 67 beaches (Fig. 7), 27 of them are in protected wildlife areas and the remaining 40 are outside protected wildlife areas. It is the most abundant species in the Costa Rican Pacific and the one with the widest range of nesting. For this report, information was compiled from 23 important sites (69.4 km of beach length), seven of them considered as an index (see Table 1 and Table 2).

Although the seven species of marine turtles share a generalized nesting behavior, they differ in their temporal space patterns. For example, the most unusual of all species is the Olive ridley turtle, which presents two types of reproductive strategies. The solitary nesting, each independent of the other, and the nesting that occurs under an "arribada" ("arrival" in English), in which thousands of females emerge from the sea in a synchronized manner, in mass and for short periods of days (2-7 days) to lay their eggs on the beach (3). Precisely in two Costa Rican beaches, this behavior has been widely documented, Ostional and Nancite. However, massive nesting of olive ridley is also reported in Corozalito beach, with a nest/year average of 39274, as shown in Table 2. Details about the number of nests and females in arrival periods can be seen in Table 1.

The females that nest in a solitary way do so mostly in defined seasons that coincide with the months of July to November, although there are nestings in months before and after the season. In addition, the arribada happens approximately once a month.

Playa Nancite is a protected beach under the category of National Park. The arribada in this site are smaller and less frequent compared to those occurring in Ostional. According to Valverde et. al. (1998), the population had shown a marked decline between 1987 and 1996. Possibly related to a low success rate in recruitment. A high concentration of nesting females in a small space, resulted in a low production of neonates due to high mortality of density-dependent eggs, to which were added high concentrations of fungi and bacteria, as well as important predation (3,20,29). However, Fonseca et. al. (2009) and information compiled for this report (see Table 1), indicate that although the arrival population in Nancite suffered a significant decrease in the last 36 years, it is currently experiencing low but stable numbers.

In Costa Rica, environmental laws prohibit the use of sea turtles' eggs, however, in the case of Ostional, which is a protected beach under the category of Mixed National Wildlife Refuge, it is the only place in the country where the community has a Project for the management and conservation of Olive ridley sea turtles, whose eggs collection is authorized by the State and it is the only exception in Costa Rica within the framework of the IAC, according to Resolution CIT-COP7-2015-R1.

This project is a community management model that contributes to the conservation of sea turtles, to the sustainable use of sensitive natural resources such as olive ridley turtle eggs. The Ostional National Wildlife Refuge has a management plan that operationalizes the project's actions for five years. The Plan contains objectives, principles, norms for the governance and its implementation. These norms were developed by representatives of the Ostional community through the Association for Integral Development (ADIO); the Costa Rican Fisheries Institute (INCOPESCA); the National System of Conservation Areas (SINAC), and the University of Costa Rica (UCR) (35). In addition, the administration of the Wildlife Refuge is supported by an Interinstitutional Advisory Council and a permanent biological monitoring program for the olive ridley turtle population.

Even so, the arribada in Ostional was discovered in the 70s and since the end of the 80s the legal extraction of eggs by the community is allowed, little scientific information is published. According to Valverde et. al. (2012), the arrival shows large intra- and inter-annual fluctuations, so it has not been possible to discern a concrete population trend. However, for Cornelius et. al. (2007) and Plotkin et. al. (2012), the population that nests in Ostional seems stable and may be growing. Given this situation, it is essential to continue monitoring until we have gathered enough information to determine the population trend.

Attention to this species has focused on arribada beaches. However, solitary nesting sites are important, and in many of them, a monitoring and conservation program has been consolidated, it is the case of the beaches shown in Table 2. According to Dornfeld et. al. (2015), solitary nesting turtles contribute to the olive ridley population in the Eastern Tropical Pacific. For example, they found that solitary nesting beaches could be key sites for male hatchlings, as nests laid between June and September (rainy season) were incubating under cooler temperatures than those recorded on arribada beaches. Hatching successes were higher according to recent data presented in this report, and emergence success was higher than that shown on the arribada beaches (see Table 1).

The Olive ridley sea turtle shows low fidelity to solitary nesting sites. This is proven by the low numbers of recaptured individuals at monitoring sites. Even then, the number of nests that are reported at nesting sites is very relevant to the conservation status of the species. Therefore, the beaches identified and highlighted in this report should, to the extent possible, be maintained under a nest monitoring and protection program.

3.1.2. Marine areas

Plotkin (2010), who determined that olive ridleys are highly migratory, is one of the most complete studies carried out on the post-nesting movements of the olive ridley turtles. The females that nested in Nancite did not follow a migratory corridor and were widely distributed between the jurisdictional waters of Mexico and Peru, where most of the females migrated to deep pelagic waters and others moved near the coast, but also in deep waters (Fig. 8). She also did not observe specific feeding zones for those years of study, but she assumes that the brief stops made by the turtles along the migratory route were a positive indication of the availability of resources. Olive ridley adult turtles spend their lives in ocean waters.

3.2. Other biological data

Table 1 shows a summary of important biological and conservation information about sea turtle species in the Costa Rican Pacific.

3.3. Threats

3.3.1. Nesting areas

Table 1 shows the threats that are still affecting olive ridleys in the Pacific of Costa Rica. As is the case for all sea turtle species, egg poaching is one of the highest impacts and occurs mainly on nesting beaches outside protected wildlife areas. On a nesting beach where there is no human presence to develop activities to protect nests and females, egg poaching will be associated with a high percentage of extraction.

The low percentage of emergency success at arribada beaches (see Table 1) has an impact on the recruitment rates of individuals in olive ridley populations. According to Fonseca et. al. (2009) and Honarvar et. al. (2008), the decrease in the population at Playa Nancite could have been due to low hatching success because of a high density of nests on the beach. So, the recruitment for the population was insufficient to balance mortality. In Ostional, the combined effect of high temperatures in the nest and partial pressure of oxygen (pO2) at the beginning of the incubation, resulting from the microbial decomposition of organic matter, influence the low hatching success (4).

The reproductive success of sea turtles depends largely on the stability of the nesting beaches, and that good hatching and hatchlings' emergence successes occur. In the ocean, good conditions of productivity must exist, which favor the food and energy necessary for them to migrate and lay their eggs on the nesting beaches. The sensitivity of marine turtles to climatic variability is remarkable and makes it essential to consider the impacts of climate change in their national and regional recovery plans.

Costa Rica has recognized that the effects of climate change impact sea turtle nesting and feeding habitats. So that, in some of its beaches will be implemented the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC) project, called "Pilot Project for IAC Party Countries for the collection of environmental parameters of their nesting index beaches", for a continuous period of 5 years. It is based on the Resolution of Adaptation of sea turtle habitats to climate change CIT-COP4-2009-R5 (http://www.iacseaturtle.org/docs/resolucionesCOP4CIT/CIT-COP4-2009-R5ESP_Final.pdf).

3.3.2. Nesting areas

Bycatch remains one of the major threats to the conservation of olive ridleys in the Tropical Eastern Pacific; dead turtles are frequently observed on nesting beaches, however, published and recent information regarding the impact of fisheries on the populations of sea turtles is scarce. Relevant information was shared by Whoriskey et. al. (2011), who were able to quantify the impact of olive ridley sea turtle bycatch effect on the capture of Coryphaena hippurus (Mahi-mahi). They determined that between 1999-2008, 1348 individuals were captured, for an average of 9.05 olive ridleys per 1000 hooks. The mortality reported was low and this was because almost all the turtles observed were released. Fishing efforts were concentrated between 19.5 km and 596.2 km from the coast.

On the other hand, Drapp et. al. (2013) estimated that between 1999 and 2010, an amount of 92,300 adult olive ridleys were captured by the longline fishing fleet. The impact of these catches on the population is not easy to measure, since according to Swimmer et. al. (2006), released turtles apparently survive and behave normally. An important consideration in threat mitigation measures is that much of the effort in this fishery occurs both near and far from nesting beaches.

3.4. Conservation

Table 1 shows some of the conservation activities that have been implemented in the country for the conservation of olive ridley sea turtles. Of the 67 reported sites where nesting occurs, 27 of them are within a protected wildlife area. Twelve are the marine areas under the administration of SINAC, that were created for conservation, and ten are the Responsible fishing marine areas created under the administration of the National Fisheries Institute. The olive ridleys could eventually move within these spaces (Fig. 1a,1b).

The country has ratified nine international treaties (see Table 3) and at least 30 national legal instruments (1), which are directly related to the conservation and protection of sea turtles.

Sea turtle monitoring programs carry out protection and conservation activities for females, nests, and, to the extent of their competencies and possibilities, for the current habitats (see Table 4). The nesting beaches in protected areas have the strength to be under the protection of a specific law, a Management Plan, and a Regulation for Public Use. However, nesting beaches and marine spaces outside protected areas are at high risk to anthropogenic threats, so it is urgent to define and implement governance models that ensure the conservation of the habitat, the species, and human well-being.

3.5. Research

1. Evaluate the impact of different types of fisheries on foraging habitat, inter-nesting, and spaces where sea turtle movement occurs, identifying those areas of greatest interaction.

2. Promote research on techniques to reduce the incidental capture of sea turtles.
3. Learn about the impacts of marine debris on sea turtles (including ingestion of plastics, ghost fishing gear, microplastics).

4. Impacts of climate change on sea turtle nesting and its critical habitats.

4. RMU: Leatherback turtle (*Dermochelys coriacea*), East Pacific

4.1. Distribution, abundance, trends

4.1.1. Nesting sites

Along the Pacific coast of Costa Rica, as of 2020, 18 sites have been reported in which leatherback turtle nesting occurs (Fig. 9), 9 of them are in protected wildlife areas, and 9 of the sites are outside protected wildlife areas. For this report, the information was compiled for 14 of these sites, which have been permanently monitored over a determined period of years (see Table 2).

The major conservation efforts for the species in the country have concentrated mainly on the beaches of Parque Nacional Marino Las Baulas (PNMB). This is a complex of three sandy beaches (Playa Grande, Ventanas, and Langosta), considered as an index site for the species, and that has a nesting history since the end of the 1980s (Fig. 10) (36, 58, 60).

Leatherback nesting has also been reported at the other 15 sites. However, according to Santidrian-Tomillo et. al., (2017a), four of these sites (Naranjo, Cabuyal, Nombre de Jesús, and Ostional) can be classified as important secondary beaches due to the regular occurrence of nesting events. Playa Junquillal also appears to be an important secondary beach for leatherback turtles. It is according to the information gathered in this report.

Table 2 shows the information of the beaches Grande, Ventanas, and Langosta, as one and referred to as PNMB, this is because there are frequent exchanges between the Park beaches, and the analysis of the nesting at the three beaches independently may result in errors and underestimation of population size. The same applies to the beach complex Nombre de Jesús-Minas.

According to Santidrian-Tomillo et. al. (2017a), although nesting abundance is relatively low at secondary beaches, they host at least ~ 25% of total leatherback nesting abundance in Costa Rica. However, due to the decline in leatherback nesting on the index beach, this percentage of secondary beaches could probably be higher today.

Leatherback turtles in the Eastern Pacific have declined drastically during the last two decades, as indicated by the trends of nesting females and nests in the beaches of PNMB (Fig. 10). Steyermark et. al. (1996), Chaves et. al. (1996), Reina et. al. (2002), and Piedra et. al. (2007), in their works, described population parameters such as number of females, number of nests, mortality rates, remigration intervals, clutch size, reproductive frequency. On the other hand, Spotila et. al., (2000) and Santidrian-Tomillo et. al. (2007) described a highly threatened and declining population. According to the information collected for the 14 nesting sites included in this report, for the period comprised between 2014-2020, an amount of 214 annual leatherback nests was averaged in the Costa Rican Pacific (see Table 1). Currently, the trends do not show any recovery signs.

The current numbers continue positioning the leatherback turtles in an alarming status due to the critical estate of the population. It is very important and critical to maintain a permanent presence on the index beaches and maintain all possible efforts in all those beaches that have been classified as secondary.

Secondary beaches are considered nesting sites where turtles nest regularly, are used by the same subpopulation, and are of secondary importance due to the lower intensity of nesting activities (60). The information collected will continue to be relevant to generate important estimates of population trends.

4.1.2. Marine areas

During the nesting season, females make use of marine coastal habitats near the beaches where they nest. Shillinger et. al., (2010), determined that during the internesting period, leatherback turtles remain in an area of approximately 33 542 Km2 (Fig. 11).

Once they finish their nesting period on the Pacific coast of Costa Rica, they seem to migrate exclusively to the South Pacific, where their main foraging areas are found (Fig. 12) (2, 33, 63, 65). The persistent migrations of the Costa Rican Pacific leatherbacks to the South Pacific Gyre and their subsequent sustained residence within this region suggest that this population shows fidelity to foraging sites (63).

4.2. Other biological data

Table 1 shows a summary of important biological and conservation information about sea turtle species in the Costa Rican Pacific.

4.3. Threats

Table 1 lists the threats that affect the species in the country. Historical poaching of eggs and bycatch are possibly the two main threats that have led leatherback turtles to their current critical condition. Here are some details regarding these and other threats:

4.3.1. Nesting areas

Egg poaching is a common threat to sea turtles in Costa Rica and was one of the main drivers of the population collapse at PNMB. Approximately, 90% of leatherback clutches were poached for ~20 years before the Park was established (61). The levels of egg poaching have been reduced in Protected Wildlife Areas and in places where there are long-term monitoring projects. However, the pressure is still high, and effective conservation depends on the human presence on the nesting beaches. If there is no presence related to habitat protection, the threat of egg poaching is still high.

Coastal development without control continues to be a threat, especially when the design of developmental projects adjacents to critical habitats for marine turtles does not include conservation and protection measures. According to Roe et. al., (2013), leatherback turtles in Playa Grande (PNMB) nest more frequently in beach sections with steeper slopes, higher elevation dunes, and deeper marine areas, so the presence of vegetation, as well as the lack of infrastructure in the areas adjoining the nesting habitats, are very important.

Marine protected areas of Costa Rica must have management plans, which define a buffer zone adjacent to its official limits. The managers of marine protected areas have great interference over the real estate projects to be developed in the buffer zone. They can influence the management of light, noise, tourism, and beach activities among others. In addition, the National Environmental Technical Secretariat (Setena, acronym in Spanish), one institution of the Ministry of Environment and Energy, has as one of its functions the analysis and approval or rejection of the environmental viability instrument that must be drawn up by those responsible for real estate projects. This should consider parameters that reduce the impact of some construction activities and their subsequent project operation on the sea turtle and its habitat.

Undoubtedly, the foregoing is a fundamental technical-legal tool that, when well implemented, helps to reduce the impacts of coastal development. However, there is still a need for a greater incidence of control and compliance with environmental commitments to reduce the impact of development on nesting habitats but are important advances such as the implementation of administrative resolutions that establish guidelines for infrastructure development. Outside of protected areas, control remains more complicated and requires the commitment of many key actors.

Climate change can greatly affect leatherback populations mainly through the detrimental effect of hot and dry conditions on egg incubation. As a result, hatching and emergence success are expected to decline due to climate change by the end of the 21st century (59). In a follow-up study, Saba et. al. (2012) projected that the population of leatherback turtles that nest at PNMB will decrease at a 7% rate per decade during the 21st century due to the projected increase of air temperatures and decrease precipitation levels. The population will remain stable until 2030 but will suffer a reduction of 75% by the year 2100 due to climate change alone. The sensitivity of leatherback turtles to climatic variability is remarkable in comparison to other species (55, 57) and makes it essential to consider the impacts of climate change in their recovery plans.

Costa Rica has recognized that the effects of climate change impact sea turtle nesting and feeding habitats. So that, in some of its beaches will be implemented the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC) project, called "Pilot Project for IAC Party Countries for the collection of environmental parameters of their nesting index beaches", for a continuous period of 5 years. It is based on the Resolution of Adaptation of sea turtle habitats to climate change CIT-COP4-2009-R5 (http://www.iacseaturtle.org/docs/resolucionesCOP4CIT/CIT-COP4-2009-R5ESP_Final.pdf).

4.3.2. Nesting areas

Sea turtles are long-lived organisms with delayed sexual maturity and high fecundity that require high survival rates to keep their populations viable. Unfortunately, the nesting population of the Pacific side of Costa Rica has an estimated relatively low annual survival rate for a long-lived species, which suggests that there is an important interaction of leatherbacks with fishing (57).

In general, bycatch data are provided by observers onboard or from reports in logbooks. For small-scale or artisanal fisheries, this type of information is not available in Costa Rica, so we have very little or no information available on fishing interactions with leatherbacks in jurisdictional waters of Costa Rican Pacific. However, post-nesting leatherback turtles migrate to distance foraging grounds crossing areas where pelagic fisheries operate, Shillinger et. al. (2008) and Alfaro-Shigueto et. al. (2018) mentions the occurrence of interactions with fisheries in the oceanic and coastal areas near Ecuador, Peru, and Chile.

Roe et. al. (2014) determined that there is an area of potential risk from fishing along the leatherback migration corridor between Costa Rica and the Galapagos Islands (Fig. 12). Although they predicted in this area females would have a moderate risk of incidental capture, being a persistent migration route for leatherback turtles, it represents a potential permanent threat during a critical phase in the life cycle of adult reproductive turtles. Reducing fishery bycatch in the ocean is essential for beach protection to be effective.

Climate Change may result in changes in prey distribution or abundance. El Niño Southern Oscillation (ENSO) has been shown to influence the reproductive frequency of EP leatherbacks, most likely as a result of its impact on prey abundance in the southeast Pacific (50). During the La Niña periods, the ocean surface temperature is lower, so there is higher primary production, and turtles take fewer years to return to the beaches to lay their eggs. Otherwise, it happens during El Niño events, in which the surface temperature of the water is high, there is less primary production and therefore the turtles take more years to return to the beach to lay their eggs (42, 50).

4.4. Conservation

As mentioned in section 4.1.1, on the Pacific coast of Costa Rica, there have been 18 beaches where leatherback turtles have seen nesting (Fig. 9), 9 of these sites are under some category of State protection as National Wildlife Refuges or National Parks. In 14 nesting sites, there are long-term monitoring programs, with information available and facilitated to prepare this report (see Table 2). Twelve are the marine areas under the administration of SINAC, were created for marine conservation, and ten are the Responsible fishing marine areas created under the administration of the National Fisheries Institute. The leatherbacks of the Eastern Pacific could eventually move through these spaces (Fig. 1a,1b).

The country has ratified nine international treaties (see Table 3) and at least 30 national legal instruments (1), which are directly related to the conservation and protection of sea turtles.

Sea turtle monitoring programs carry out protection and conservation activities for females, nests, and, to the extent of their competencies and possibilities, for the current habitats (see Table 4). The nesting beaches in protected areas have the strength to be under the protection of a specific law, a Management Plan, and a Regulation for Public Use. However, nesting beaches and marine spaces outside protected areas are at high risk to anthropogenic threats, so it is urgent to define and implement governance models that ensure the conservation of the habitat, the species, and human well-being.

It is essential to maintain the monitoring and research programs on the index and secondary nesting beaches. This way ensures to continue with the generation of information, but at the same time, with a human presence on the nesting beaches as permanent as possible. It has a significant impact on reducing egg poaching and preventing other possible threats. Table 4 lists the NGOs and State institutions relate to the management, conservation, and research of sea turtles in the country.

Conservation priorities

Costa Rica has worked in the identification of its conservation priorities, which have been expressed in its recent National Strategy for the Conservation and Protection of Sea Turtles, and from which the following stand out:

1. Creation of the National Program for the Conservation and Protection of Sea Turtles. Its implementation will serve as an instrument for monitoring, and

managing activities of national legislation, international agreements, and the National Strategy for the Conservation and Protection of Sea Turtles.

2. Creation of an Inter-institutional Sea Turtle Advisory Group. Provide technical criteria and management or other recommendations to state authorities and the National Sea Turtle Conservation Program.

3. Formalize and implement governance models that help in the sustainable management of critical sea turtle habitats.

4. Evaluate sea turtle interactions with fisheries.

5. Ensure the continuity of the monitoring programs that occur inside and outside Protected Wildlife Areas.

6. Implement the Pilot Project for IAC Countries Parties for recording environmental parameters of their nesting index beaches for a continuous period of 5 years.

7. Create a database at the country level, in which the results of the studies are carried out, and the registered information of standardized monitoring indicators are systematized.

8. Develop follow-up activities to reduce trafficking and illegal trade of sea turtle products and by-products.
9. The country has identified several marine spaces that stand out for their importance for marine conservation. In recent years, some of these spaces have already been attended. Now, the work is being done to address, together with key actors, the spaces between the Las Baulas National Park and the Santa Rosa National Park (Fig. 1), known as Sector Punta Pargos - Punta Gorda and Sector Papagayo.

10. Another priority that has been discussed in the framework of the IAC is the identification and implementation of Spatio-temporal management measures in areas adjacent to nesting beaches and inter-nesting habitats. This could include temporary fishing closures and explore options for the fishing sector affected by the measure.

11. Increase observer coverage in the longline fishery.

12. Develop a standardized format for bycatch reporting.

13. Organization of a National workshop on incidental capture of turtles and mitigation measures, to determine the level of interaction and the relative mortality resulting from it in different fishing gears.

14. Develop efforts and inter-institutional coordination for training in the handling and release of sea turtles affected by bycatch.

4.5. Research

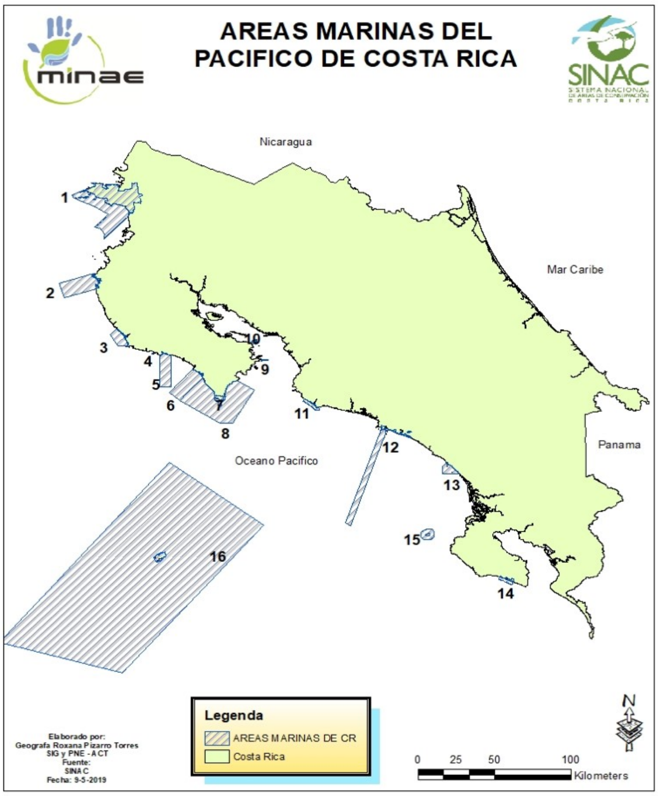
1. Evaluate the impact of different types of fisheries on foraging habitat, inter-nesting, and spaces where sea turtle movement occurs, identifying those areas of greatest interaction.

2. Promote research techniques to reduce incidental capture of sea turtles.

3. Learn about the impacts of marine debris on sea turtles (including ingestion of plastics, ghost fishing gear, microplastics).

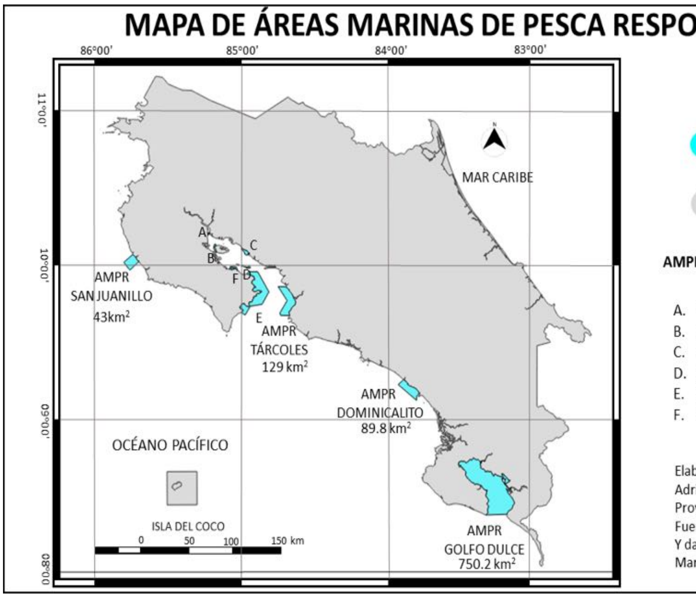
4. Impacts of climate change on sea turtle nesting and its critical habitats.

Figures



No.	NOMBRE	CATEGORIA DE MANEJO
1	Santa Rosa	Parque Nacional
2	Marino las Baulas de Guanacaste	Parque Nacional
3	Ostional	Refugio Nacional de Vida Silvestre
4	Isla Chora	Refugio Nacional de Vida Silvestre
5	Camaronal	Refugio Nacional de Vida Silvestre
6	Caletas Ario	Refugio Nacional de Vida Silvestre
7	Cabo Blanco	Reserva Natural Absoluta
8	Cabo Blanco	Area Marina de Manejo
9	Islas Negritos	Reserva Biologica
10	Isla San lucas	Refugio Nacional de Vida Silvestre
11	Playa Hermosa-Punta Mala	Refugio Nacional de Vida Silvestre
12	Manuel Antonio	Parque Nacional
13	Marino Ballena	Parque Nacional
14	Pejeperro	Refugio Nacional de Vida Silvestre
15	Isla del Cano	Reserva Biologica
16	Isla del Coco	Parque Nacional

a)



b)

Figure 1. a). Map of Marine Protected Areas and Marine Management Areas, Pacific of Costa Rica (Source: SINAC); b). Marine Areas of Responsible Fishing, Pacific of Costa Rica (Source: INCOPESCA).

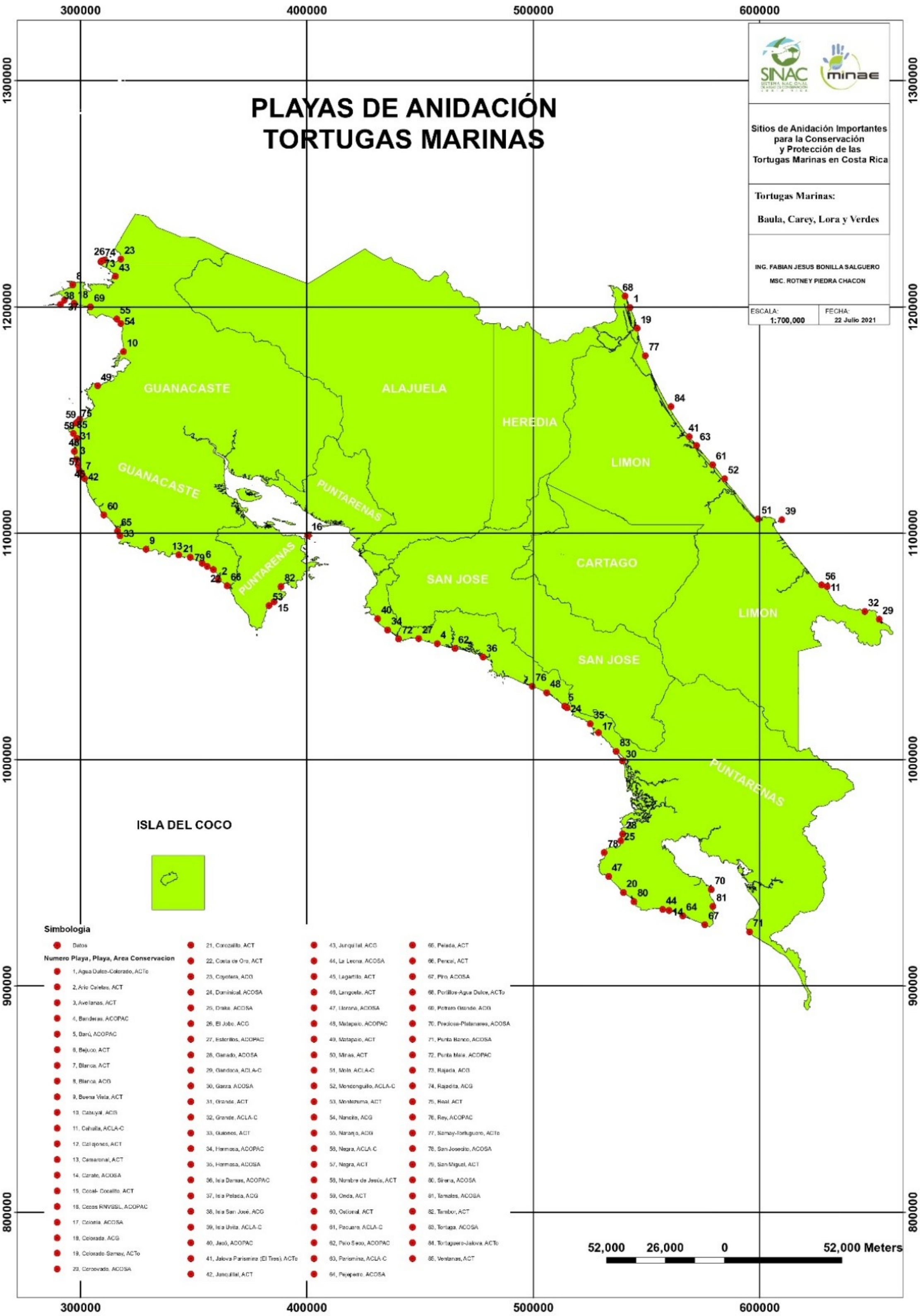


Figure 2. Nesting beaches of sea turtles in the Pacific and Caribbean coast of Costa Rica.

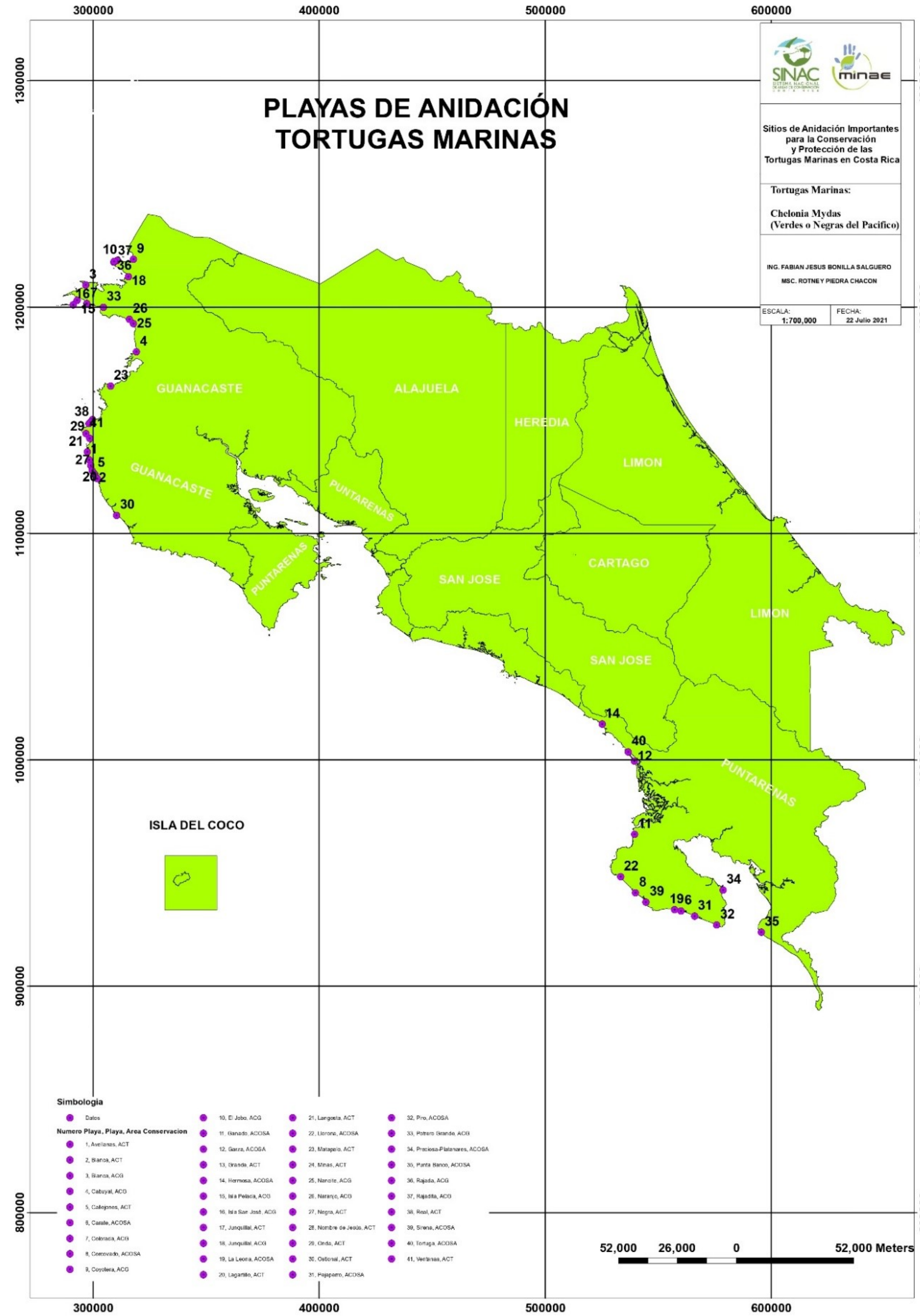


Figure 3. Nesting beaches where green turtles are reported.

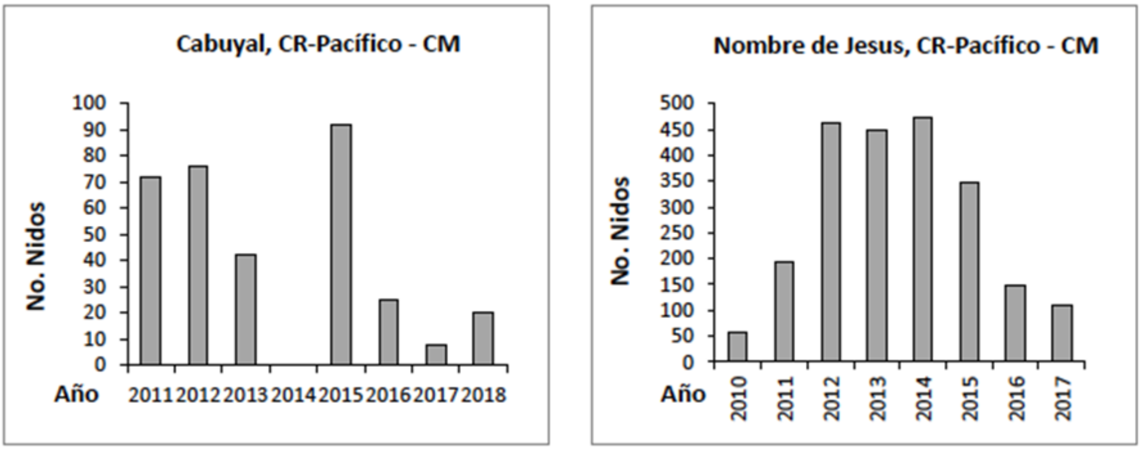
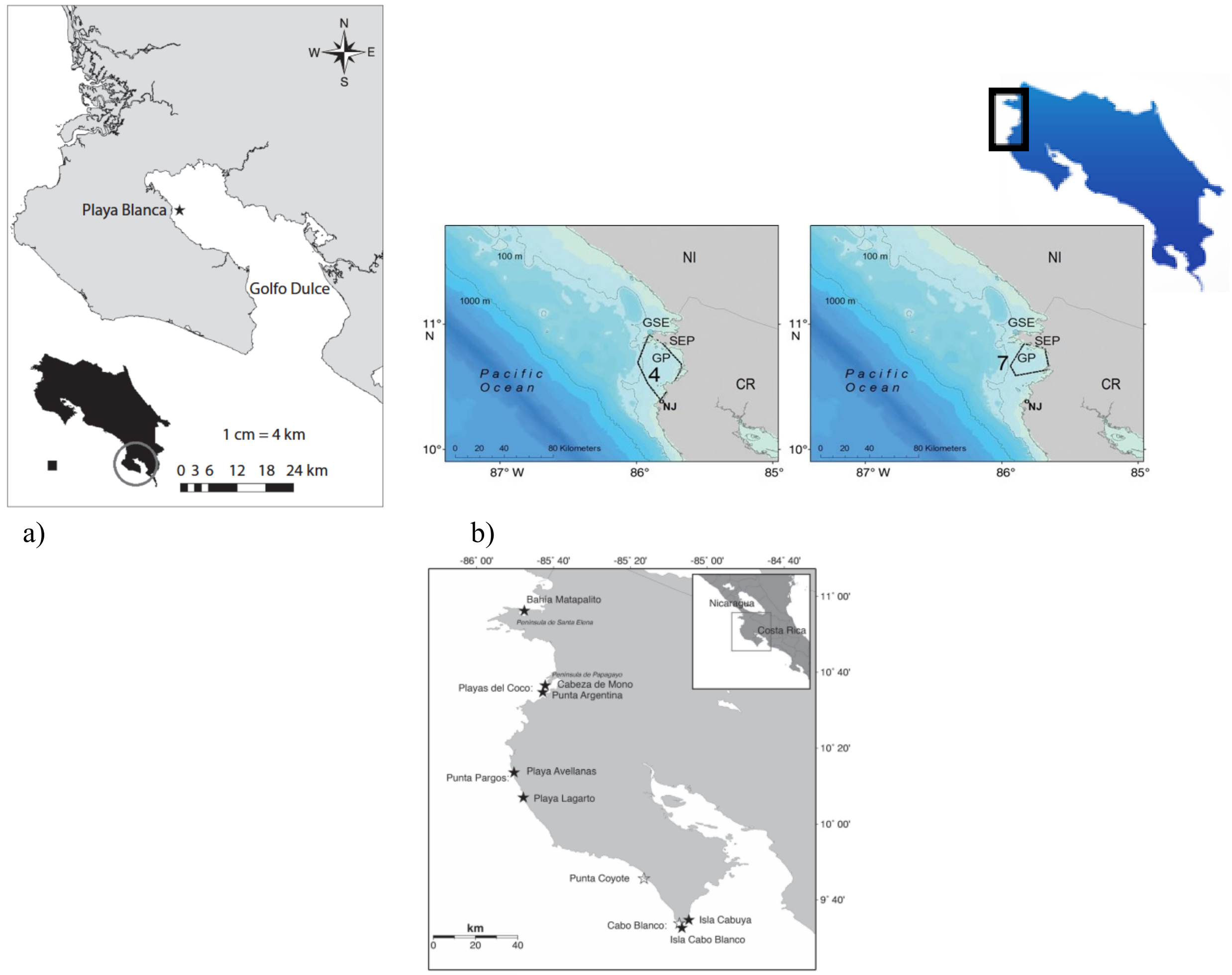


Figure 4. Number estimated of green turtle nest in index beaches (Cabuyal, Nombre de Jesús) (CIT 2018).



c)

Figure 5. Foraging areas for balck turtle (a, b, c) and Hawksbill turtle (a, c) in the Pacific of Costa Rica. a). Golfo dulce (Map taken from Chaverri-Chacón et. al., 2014a); b). Gulf of Papagayo (GP) and Gulf of Santa Elena (GSE) two foraging areas of green turtles from Nombre de Jesús (NJ), Costa Rica (CR) (Map taken from Blanco et. al., 2012b); c) Foraging grounds for green sea turtles and hawksbill sea turtles: Bahía Matapalito, Punta Pargos, Punta Coyote and Cabo Blanco (Map taken from Heidemeyer et. al., 2014).

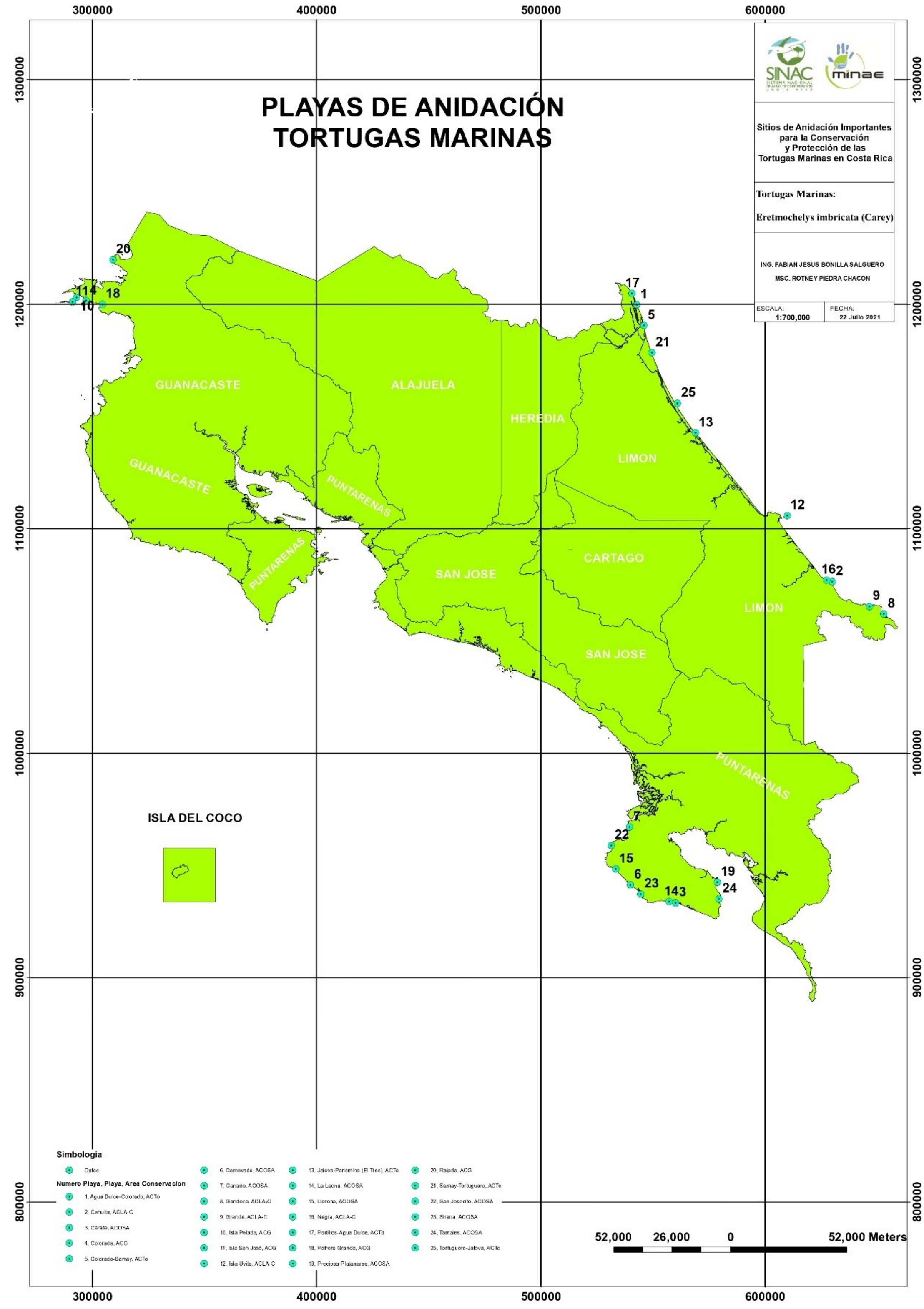


Figure 6. Nesting beaches where hawksbill turtles are reported.

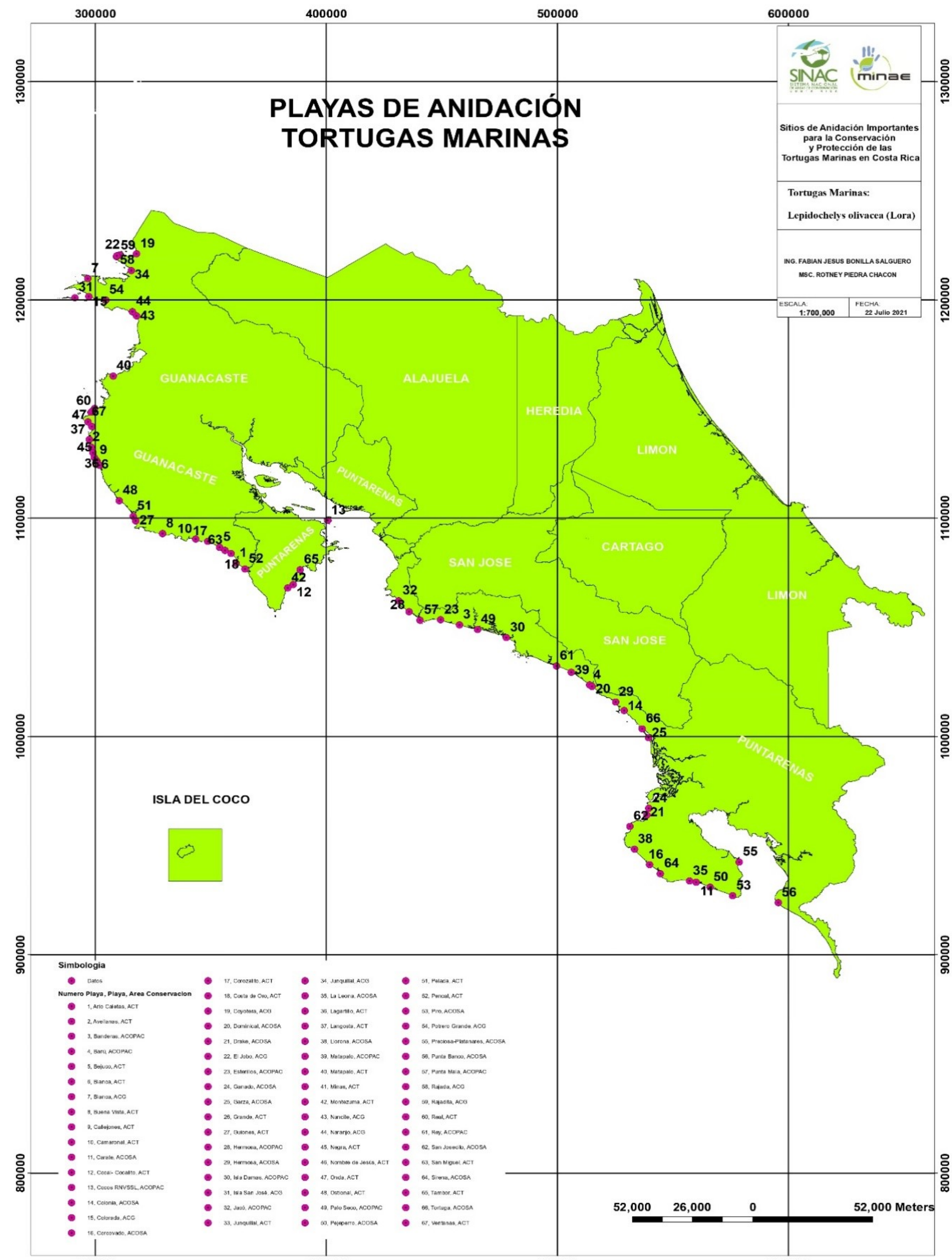


Figure 7. Nesting beaches where Olive ridley turtles are reported.

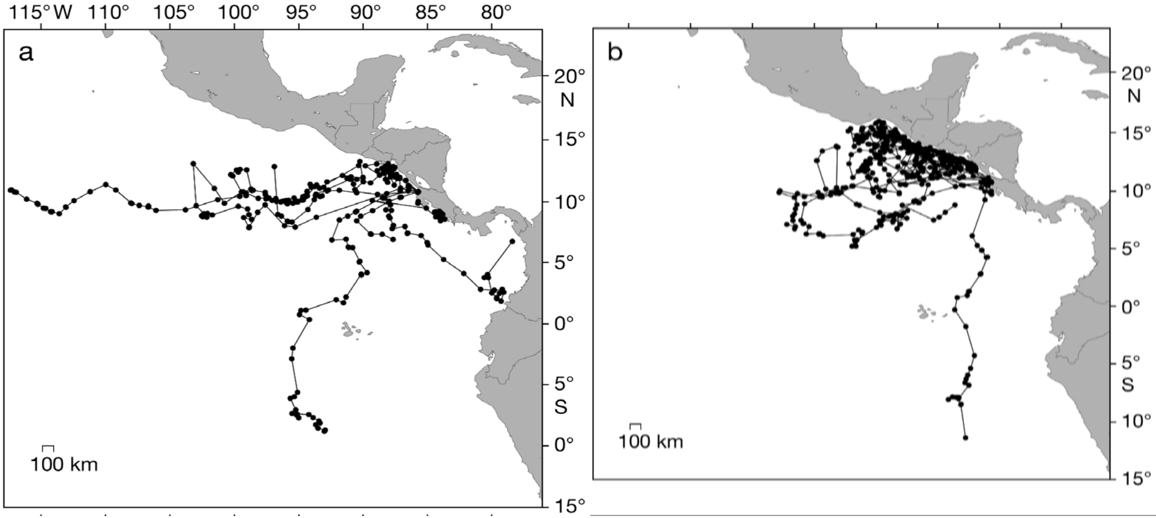


Figure 8. *Lepidochelys olivacea.* Post-nesting migrations of 20 female olive ridleys during (a) 1990–1991 and (b) 1991–1992. Map taken from Plotkin 2010.

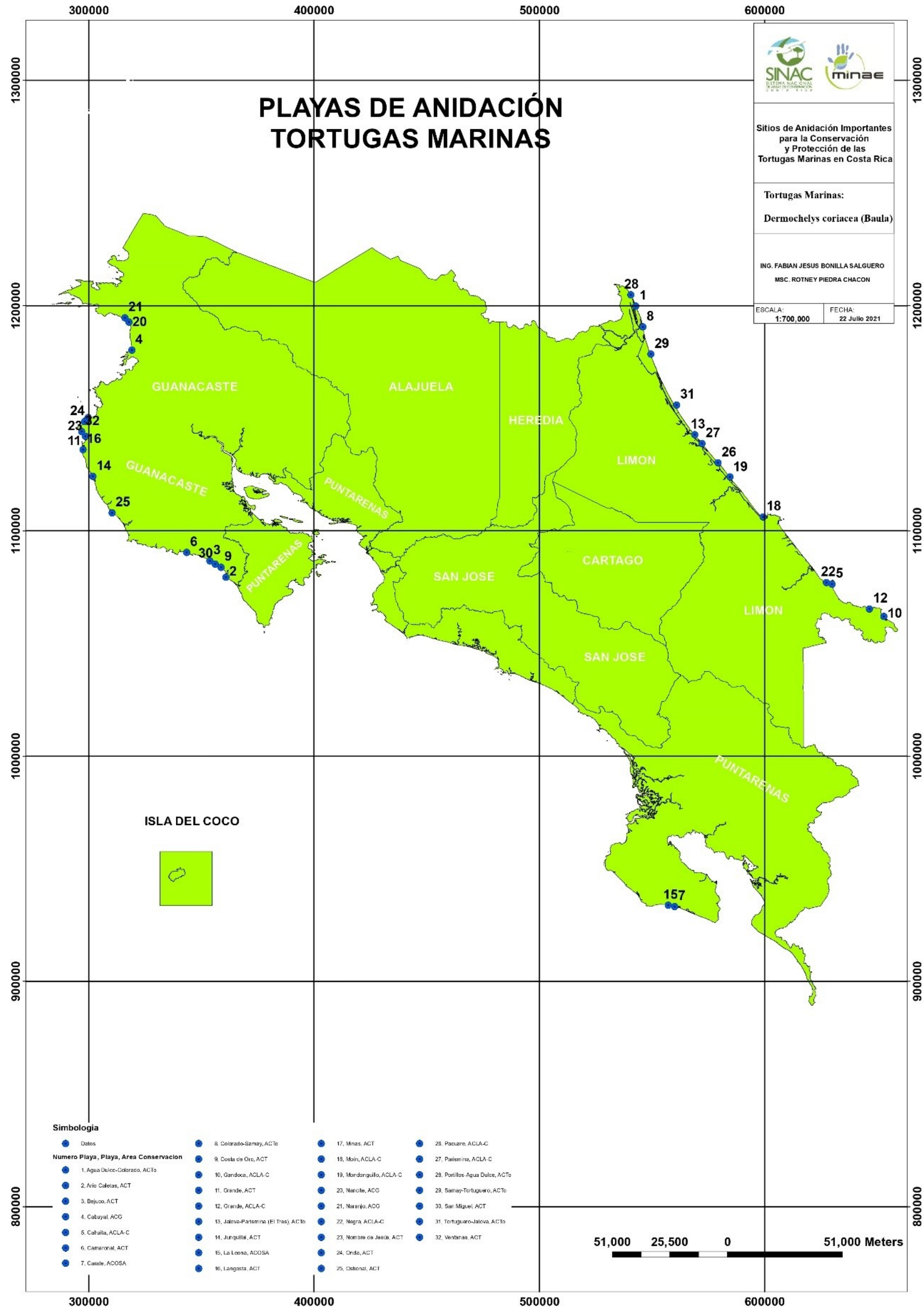


Figure 9. Nesting beaches where leatherbacks are reported.

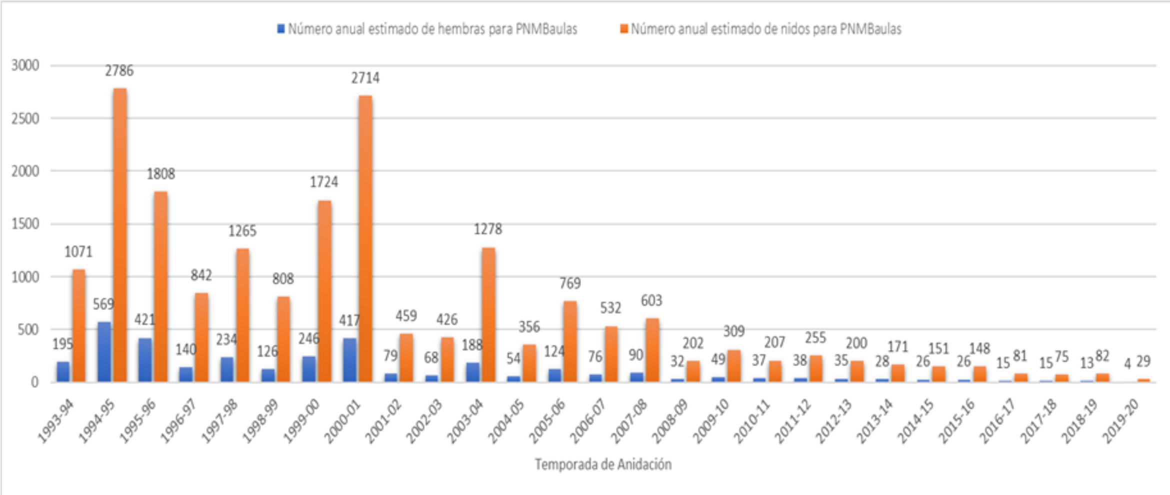


Figure 10. Estimated anual number of females and estimated anual number of nests. Source from TLT, KUEMAR, SINAC.

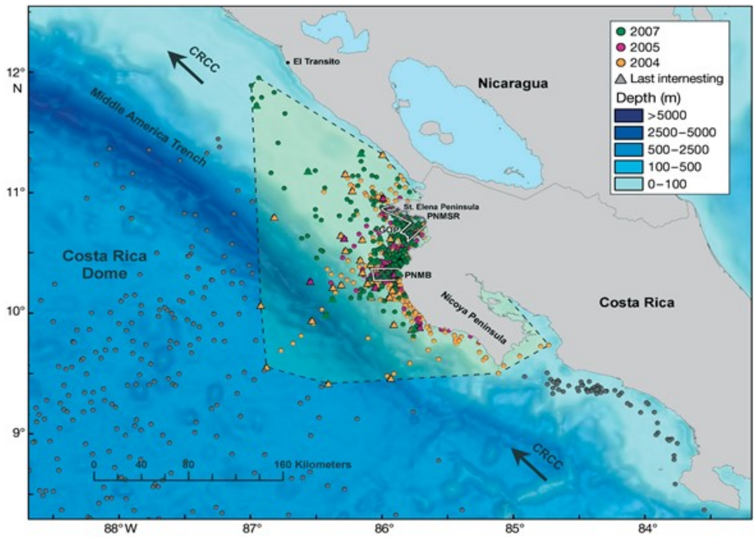


Figure 11. The polygon shows the area where the leatherbacks move during their internesting period. (Map taken from Shillinger et. al., 2010).

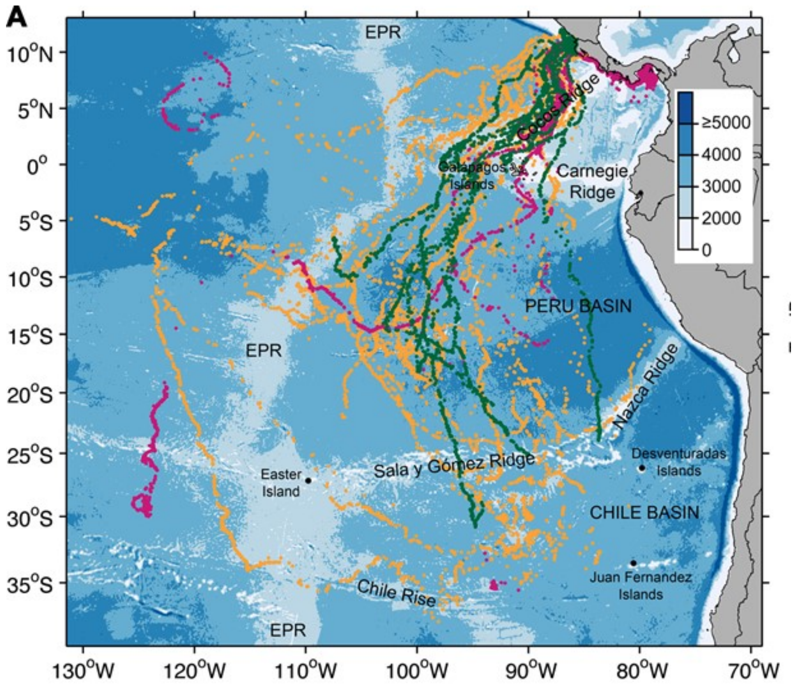


Figure 12. Migration route. Satellite transmission positions for Dermochelys coriacea from 2004, 2005 and 2007 (Map taken from Shillinger et. al., 2008).

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Table 1. Biological and conservation information about sea turtle Regional Management Units in Costa Rica.

RMU:	*C. mydas* EP	Ref #	*E. imbricata* EP	Ref #	*L. olivacea* (arribadas) EP	Ref #	*L. olivacea* (solitary nesting) EP	Ref#	*D. coriacea* EP	Ref #
Occurrence										
Nesting sites	Y	5,19,21, 28,32,	N	PS	Y	PS,20,32	Y	PS,32,49	Y	PS,32,58,60,61
Oceanic foraging areas	N	PS,62	N	PS	N	PS	N	PS	N	PS
Neritic foraging areas	JA	6,24,27, 28	JA	25, 28	N	PS	N	PS	N	PS
Key biological data										
Nests/yr: recent average (range of years)	2096(2014-2020)	PS,32,21	44 (2016-2020)	PS	922350 (2014-2020)	PS,32	11912 (2014-2020)	PS,32	214 (2014-2020)	PS,32
Nests/yr: recent order of magnitude	3-1698	PS	1_40		487284-1221346	PS	16-3480	PS	1-171	PS
Number of "major" sites (>20 nests/yr AND >10 nests/km yr)	11	PS	1		3	PS	19	PS	2	PS
Number of "minor" sites (<20 nests/yr OR <10 nests/km yr)	6	PS	2	PS	0	PS	1	PS	6	PS
Nests/yr at "major" sites: recent average (range of years)	2039 (2014-2020)	PS			922350 (2014-2020)	PS	11896 (2014-2020)	PS	148 (2014-2020)	PS
Nests/yr at "minor" sites: recent average (range of years)	57 (2014-2020)	PS			n/a		16 (2014-2020)		66 (2014-2020)	PS
Total length of nesting sites (km)	50.6	PS	U		8.4	PS	67.6	PS	39.7	PS
Nesting females / yr	617	PS	U		478129	PS	3807	PS	37.7	PS
Nests / female season (N)	U	PS	U		2.2	PS	1,65 (1929)	PS	5,6 (>110)	PS
Female remigration interval (yrs) (N)	2,6(63)	PS	U		2.0		U		3.65	57
Sex ratio: Hatchlings (F / Tot) (N)	U		U		U		U		0.85	56
Sex ratio: Immatures (F / Tot) (N)	U		U		U		U		U	
Sex ratio: Adults (F / Tot) (N)	U		0.66 (57)	PS	U		U		U	
Min adult size, CCL or SCL (cm)	79,2 (CCL)	PS	62,83 CCL	PS	58,5 (CCL)	PS	66,5 (CCL)	PS	144 (CCL)	PS
Age at maturity (yrs)	20-30	PS								
Clutch size (n eggs) (N)	73,6(> 3000)	PS	114,5 (40)	PS	92,7 (> 8000)	PS	87,7 (> 5000)	PS	66,9 (867)	PS
Emergence success (hatchlings/egg) (N)	0,87 (> 2500)	PS	U		0,35 (> 8000)	PS	0,71 (> 5000)	PS	0.32 (>1000)	PS
Nesting success (Nests/ Tot emergence tracks) (N)	0,60 (> 5000)	PS	0.70	PS	U		U		0.90	PS
Trends										

Recent trends (last 20 yrs) at nesting sites (range of years)	U		Declining		Stable	PS, 20	U	PS	Declining (90%)(1988-2018)	45,58,60,61
Recent trends (last 20 yrs) at foraging grounds (range of years)	U		n/a		n/a		U	PS	n/a	
Oldest documented abundance: nests/yr (range of years)	n/a		n/a		Y	70.71	U	PS	Y	11,41,66,67
Published studies										
Growth rates	N	PS	N	PS	N	PS	N	PS	Y	39
Genetics	Y	19.24	Y	25.28	N	PS	N	PS	Y	15
Stocks defined by genetic markers	Y	19,28,24	Y	25.28	N	PS	N	PS	Y	
Remote tracking (satellite or other)	Y	5	N	PS	N	PS	N	PS	Y	63,64,65
Survival rates	N		N	PS	N	PS	N	PS	Y	
Population dynamics	N		N	PS	N	PS	N	PS	Y	56,58,60,61
Foraging ecology (diet or isotopes)	Y	PS, 62	Y	PS	N	PS	N	PS	Y	73
Capture-Mark-Recapture	Y	PS,10	Y	PS	Y	PS	Y	PS	Y	PS,11,36,41,60,67,
Threats										
Bycatch: presence of small scale / artisanal fisheries?	Y (SN, OTH)	PS	Y (SN, OTH)	PS	Y(PLL, ST,)	PS	Y(PLL, ST,)	PS	N	
Bycatch: presence of industrial fisheries?	Y (PLL, SN, BT)		Y (PLL, SN, BT)	PS	Y(PLL, ST,)	PS	Y(PLL, ST,)	PS	N	
Bycatch: quantified?	N		N	PS	10 (PLL)/9,4 per 1000 hooks (Mahi mahi fisheries)	PS,16,74	10 (PLL)/9,4 per 1000 hooks (Mahi mahi fisheries)	PS,16,74	N	
Intentional killing of turtles	N	PS	Y (2-5 per year)	PS	N	PS	N	PS	N	
Take. Illegal take of turtles	N		Y	34	N				N	
Take. Permitted/legal take of turtles	N		N		N				N	
Take. Illegal take of eggs	Y	32	Y	PS	Y	PS	Y	PS	Y	61
Take. Permitted/legal take of eggs	N		N		Y				N	
Coastal Development. Nesting habitat degradation	Y	32	Y	PS	Y	PS	Y	PS	Y	48
Coastal Development. Photopollution	Y	32	Y	PS	Y	PS	Y	PS	Y	
Coastal Development. Boat strikes	Y (2-5 per year)	32	Y (2-5 per year)	PS	Y (7-10 Per year)	PS	Y (7-10 Per year)	PS	Y	
Egg predation	Y	PS	Y	PS	Y	PS	Y	PS	Y	
Pollution (debris, chemical)	Y	32	Y	PS	Y	PS	Y	38	Y	46
Pathogens	Y	32	Y	PS	Y	PS	Y	PS	n/a	
Climate change	Y	32, 55,72,4	Y	PS	Y	PS	Y	PS	Y	42,50,51,52,53,54,59,

		0								
Foraging habitat degradation	Y (Contaminants)	32	Y (Contaminants)	PS	Y	PS	Y	PS	N	
Other	Y (Ghost fishing gear)	PS	Y (Ghost fishing gear)	PS	Artisanal fisheries	PS	Artisanal fisheries	PS	N	
Long-term projects (>5yrs)										
Monitoring at nesting sites (period: range of years)	Y (2006-2020)		Y	PS	Y (2010-2020)	PS	Y (1998-2020)	PS	Y (1993-2020)	
Number of index nesting sites	5	32	0	PS	2	PS	5	PS	1	
Monitoring at foraging sites (period: range of years)	Y (2010-2020)	10,24,25,27,28	Y (2014-2020)	PS	n/a		n/a		n/a	
Conservation										
Protection under national law	Y	31.32	Y	PS	Y	32	Y	2	Y	32
Number of protected nesting sites (habitat preservation) (% nests)	4 (32,4%)	PS	0	PS	2 (96%)	PS	4 (44%)	PS	9 (78,2%)	PS
Number of Marine Areas with mitigation of threats	22	PS	22	PS	22	PS	22	PS	22	PS
N of Long-term conservation projects (period: range of years)	17 (2006-2020)	Table 4	2 (2010-2020)	Table 4	3 (2010-2020)	Table 4	10 (1998-2020)	Table 4	8 (1993-2020)	58, 60, Table 4
In-situ nest protection (eg cages)	Y	PS	Y	PS	Y	PS	Y	PS	Y	PS
Hatcheries	Y	PS	N	PS	Y	PS	Y	PS	Y	PS
Head-starting	N	PS	N	PS	N	PS	N	PS	N	PS
By-catch: fishing gear modifications (eg, TED, circle hooks)	Y (TED)	PS	Y (TED)	PS	N	PS	N	PS	N	PS
By-catch: onboard best practices	Y	PS	Y	PS	N	PS	N	PS	N	PS
By-catch: spatio-temporal closures/reduction	N	PS	N	PS	N	PS	N	PS	N	PS
Other	N	PS	N	PS	N	PS	N	PS	N	PS

Table 2. Sea turtle nesting beaches in Costa Rica.

RMU / Nesting beach name	Index site	Nests/yr: recent average (range of years)	Crawls /yr: recent average (range of years)	Western limit		Eastern limit		Central point		Length (km)	% Monitored	Reference #	Monitoring Level (1-2)	Monitoring Protocol (A-F)
CM-EPO IND				Long	Lat	Long	Lat	Long	Lat					
Playas Nombre de Jesús, Minas, Onda	Y	694 (2014-2020)						-85.834599	10.39442	1.7	100	PS	1	D
Playa Cabuyal	Y	195 (2014-2020)						-85.653405	10.675365	1.4	100	PS	1	D
Isla San José	Y	597 (2014-2017)						-85.912374	10.856928	0.1	100	PS	1	D
Playa Nancite	N	9 (2014-2020)						-85.711894	10.809324	1.1	100	PS	1	D
Playa Naranjo	N	35 (2014-2020)						-85.699344	10.805686	4.0	50	PS	2	D
Playa Coyotera	N	5 (2016-2018)						-85.721481	11.041878	0.9	100	PS	1	D
Playa Coquito	N	9,5 (2017-2018)						-85.732365	11.045944	0.4	100	PS	1	D
Playa El Jobo	N	68 (2016-2018)						-85.734743	11.033851	0.8	100	PS	1	D
Playa Rajadita	N	25 (2016-2018)						-85.75139	11.025429	0.3	100	PS	1	D
Playa Rajada	N	30 (2016-2018)						-85.746064	11.028376	0.8	100	PS	1	D
Playa Piro	N	50 (2014-2020)						-83.338702	8.3954722	2.0	100	PS	1	D
Playa Pejeperro	Y	147(2014-2020)						-83.371519	8.4073861	4.5	100	PS	1	D
Playa Junquillal	N	15(2015-2020)						-85.809437	10.161793	5.3	100	PS	1	D

Playas Pargos (Avellanas, Lagartillo, Negra, Callejones, Blanca)	Y	108 (2013-2020)						-85.836332	10.201512	7.7	100	PS	1	D
Playa Ostional	N	28 (2014-2020)						-85.700403	9.993913	7.0	100	PS	1	D
Playa Hermosa Uvita	N	3(2020)						-83.77181822	9.18618409	5.0	100	PS	1	D
Playa Tortuga	N	4(2009-2020)						-83.66749953	9.07555360	1.4	100	PS	1	D
Playa Platanares (Preciosa)	N	24(2020)						-83.28641767	8.52419978	6.0	100	PS	1	D
DC-EPO IND														
Playas Parque Nacional Marino Baulas (Grande, Ventanas y Langosta)	Y	125 (2013-2020)						-85.843432	10.327754	6.0	100	PS	1	D
Playa Ostional	N	23 (2014-2020)						-85.700403	9.993913	7.0	100	9	1	D
Playas Nombre de Jesús, Minas, Onda	N	10 (2014-2020)						-85.834599	10.39442	1.7	100	PS	1	D
Playa Cabuyal	N	14 (2013-2020)						-85.653405	10.675365	1.4	100	PS	1	D
Playa Naranjo	N	11 (2014-2020)						-85.699344	10.805686	4.0	95	PS	2	D
Playa Junquillal	N	17(2014-2020)						-85.809437	10.161793	5.3	100	PS	1	D
Playa Camaronal	N	8 (2019-2020)						-85.444924	9.86236	3.0	100	PS	1	D
Playas San Miguel, Costa de Oro, Bejuco	N	6 (2014-2020)						-85.31217524	9.81321026	10.6	100	PS	1	D
LO-EPO IND														
Playa Nancite (arribada)	Y	81286 (2014-2020)						-85.711894	10.809324	1.1	100	PS	1	F
Playa Naranjo	N	764 (2014-						-	10.8056	4.0	50	PS	2	

		2018)						85.699344	86					
Playa Ostional (arribada)	Y	801790 (2014-2020)						-85.700403	9.993913	7.0	100	PS	1	F
Playa Ostional (solitaria)	N	2118 (2014-2020)												
Playa Camaronal	Y	1528 (2014-2020)						-85.444924	9.86236	3.0	100	PS	1	D
Playa Rajada	N	67 (2016-2018)						-85.746064	11.028376	0.9	100	PS	1	D
Playa Rajadita	N	16 (2016-2018)						-85.75139	11.025429	0.3	100	PS	1	D
Playa El Jobo	N	18 (2016-2018)						-85.734743	11.033851	0.8	100	PS	1	D
Playa Coquito	N	45,5 (2017-2018)						-85.732365	11.045944	0.4	100	PS	1	D
Playa Coyotera	N	78,3 (2017-2018)						-85.721481	11.041878	0.9	100	PS	1	D
Playa San Miguel	Y	6000 (2014-2020)						-85.311402	9.81221	2.5	100	PS	1	D
Playa Costa de Oro	Y	2400 (2012-2020)						-85.284919	9.796089	4.6	100	PS	1	D
Playa Bejuco	Y	2000 (2016-2020)						-85.332842	9.822719	3.5	100	PS	1	D
Playa Corozalito (arribada)	Y	39274 (2014-2020)						-85.37777	9.847904	0.8	100	PS	1	D
Playa Piro	N	481(2014-2020)						-83.338702	8.3954722	2.0	100	PS	1	D
Playa Pejeperro	N	606(2014-2020)						-83.371519	8.4073861	4.5	100	PS	1	D
Playa Montezuma	N	200 (2011-2020)						-85.063628	9.6580138	0.8	100	PS	1	D
Playa Buena Vista	N	461 (2017-2020)						-85.941333	10.468641	1.8	100	PS	1	D
Playa Junquillal	N	234(2015-2020)						-85.809437	10.161793	5.3	100	PS	1	D

Playa Hermosa- Punta Mala	N	1424 (2002-2011)						-84.5869478	9.5727856	8.0	50	PS	2	D
Playa Hermosa (Uvita)	N	51 (2020)						-83.77181822	9.18618409	5.0	100	PS	1	D
Playa Tortuga	N	69 (2014-2020)						-83.66749953	9.07555360	1.4	100	PS	1	D
Playa Platanares (Preciosa)	N	747 (2020)						-83.28641767	8.52419978	6.0	100	PS	1	D
Playa Ario	N	190 (2018-2020)						-85.26944339	9.75944116	5.0	70	PS	1	D
Ei-EPO IND														
Playa Rajada	N	3 (2016-2018)						-85.746064	11.028376	0.8	100	PS	1	D
Playa Platanares (Preciosa)	N	40 (2019-2020)						-83.28641767	8.52419978	6.0	100	PS	1	D
Playas San Miguel, Costa de Oro, Bejuco, Corozalito (ACT)	N	1 (2014-2020)						-85.31217524	9.81321026	11.4	100	PS	1	D

Table 3. International conventions protecting sea turtles and signed by Costa Rica.

International Conventions	Signed	Binding	Compliance measured and	Species	Conservation actions	Relevance to sea turtles

			reported			
Inter-American Convention (IAC) for the Protection and Conservation of Sea Turtles	Y	Y	Y	ALL		
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	Y	Y	Y	ALL	Deincentivizes harvest of sea turtle products.	Prohibits international trade of sea turtle products.
The RAMSAR Convention	Y	Y	Y	ALL	It is intended to join efforts to build capacities in the Contracting Parties of both Conventions to achieve the rational use of Ramsar Sites, which contain essential habitats for sea turtles.	The Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC) and the Convention on Wetlands (Ramsar, Iran 1971) signed in July 2012, a Memorandum of Understanding (MoU) between the Secretariat of the Ramsar Convention and the Secretariat pro tempore of the CIT. The signature of this MOU responds to the recognition of the threatened status of sea turtle species in the Americas and the knowledge that the critical habitats (feeding, reproduction, migration and nesting) of these species are part of marine-coastal wetlands. Some of which are on the List of Wetlands of International Importance or are potential areas for designation. This agreement is under review for renewal.
Convention for the Conservation of Biodiversity and Protection of Wild Protected Areas in Central America	Y	Y	Y	ALL	Its actions are aimed to conserve biological diversity and the biological resources of the Central American region by means of sustainable use.	Develop Monitoring programs, ecosystem protection, sustainable use, creation of protected areas
Convention on Biological Diversity	Y	Y	Y	ALL	Its actions are aimed at the conservation of biological diversity, the sustainable use of its components and the fair and equitable participation in the benefits derived from the use of genetic resources, through, among other things, adequate access to these resources. and an appropriate transfer of relevant technologies, taking into account all rights to these resources and technologies, as well as	Establish a system of protected areas or areas where special measures must be taken to conserve biological diversity. It will promote the protection of ecosystems and natural habitats and the maintenance of viable populations of species in natural environments

					through appropriate financing.	
Convention on Fishing and Conservation of Living Resources of the High Seas	Y	Y	Y	ALL	All States have the duty to adopt, or to cooperate with other States in adopting, such measures for their respective nationals as may be necessary for the conservation of the living resources of the high seas.	The problems related to the conservation of the living resources of the high seas are such that there is a clear need to resolve them, whenever possible, on the basis of international cooperation through the concerted action of all States.
United Nations Convention on the Law of the Sea	Y	Y	Y	ALL	Agreement that is aimed at resolving, in a spirit of mutual understanding and cooperation, all issues related to the law of the sea and aware of the historical importance of this Convention as an important contribution to the maintenance of peace, justice and progress for all the peoples of the world.	
Code of Conduct for Responsible Fisheries of the FAO Committee on Fisheries	Y	Y	Y	ALL	Serve as an instrument of reference to help States to establish or to improve the legal and institutional framework required for the exercise of responsible fisheries and in the formulation and implementation of appropriate measures; Promote protection of living aquatic resources and their environments and coastal areas; provide standards of conduct for all persons involved in the fisheries sector.	It should help to reduce the impact of fisheries on sea turtles

United Nations Framework Convention on Climate Change	Y	Y	Y	ALL	Its actions are aimed at achieving the stabilization of greenhouse gas concentrations in the atmosphere at a level that prevents dangerous anthropogenic interference with the climate system.	Climate change has become one of the main threats to sea turtles and biological processes. High temperatures negatively affect several aspects of the life cycle of these species, both on the beach and in the sea, so that the increase in temperature due to climate change can be highly detrimental to the future of their populations.

Table 4. Projects and databases on sea turtles in Costa Rica.

#	RMU	Region / Location	Project Name or descriptive title	Key words	Start date	End date	Leading organisation	Public/Private	Collaboration with	Reports / Information material	Current Sponsors	Primary Contact (name and Email)	Other Contacts (name and Email)
T4.1	CM-LO-DC (EPO)	América Central, Santa Cruz, Guanacaste, Pacífico Norte	Conservation and Monitoring Program of sea turtles in the North Pacific of Costa Rica-Kuemar organization	Nesting female; monitoring, nest protection	2014	2020	Elizabeth Velez / Rotney Piedra	Private	SINAC MINAE	www.kuemar.org / www.sinac.go.cr	US FWS / Fundecodes / Volunteers Organizations	Elizabeth Vélez (evelez@kuemar.org)	Rotney Piedra (rotney.piedra@sinac.go.cr)
T4.2	CM-DC (EPO)	América Central, Guanacaste, Pacífico Norte	Sea Turtles of North Pacific Costa Rica	Monitoring, research, population, sea turtle, temperature	2014	2020	The Leatherback Trust	Private	SINAC-MINAE		Earthwatch Institute/NFWF	Pilar Santidrián (bibi@leatherback.org)	Frank Paladino (Frank@leatherback.org)
T4.3	CM-LO-DC (EPO)	América Central, Guanacaste, Pacífico Norte	Monitoreo y Conservación de tortugas marinas del Área de Conservación Guanacaste	Nesting female; monitoring, nest protection	2014	2020	Luis Fonseca	Private	SINAC MINAE		GDFCF / Turtle Island Conservation Network	Luis Fonseca (luisfonsecalopez@gmail.com)	
T4.4	CM-LO-DC (EPO)	América Central, Guanacaste, Pacífico Norte	Programa de Monitoreo, Marcaje y Morfometria de Tortugas Marinas en el Area de Conservacion Tempisque. Refugio Nacional de Vida Silvestre Camaronal y Refugio Nacional de Vida Sulvestre Ostional	Nesting female; monitoring, nest protection	2019	2020	Carlos Mario Orrego, Luis Fonseca, Yeimy Cedeño, Wagner Quiros, Roldan Valverde, Fabricio Alvarez	Public, Interinstitucional-MINAE-SINAC	SINAC MINAE	www.sinac.go.cr	FUNDECODES, Biocenosis Marina	Carlos Mario Orrego Vásquez (corrego@minae.go.cr; carlos.orrego@sinac.go.cr)	Fabricio Alvarez (fabricio.alvarez@sinac.go.cr); Yeimy Cedeño (yeimy.cedeno@sinac.go.cr)
T4.5	CM-LO (EPO)	América Central, Puntarenas, Pacífico Sur	Sea Turtles Conservation Program Reserva Playa Tortuga	Nesting female; monitoring, nest protection	2014	2020	Oscar Brenes	Private	SINAC MINAE	www.reservaplayatortuga.org	Volunteers organizations	Oscar Brenes (rptojochal@gmail.com)	NA
T4.6	CM-LO-DC (EPO)	América Central, Guanacaste, Pacífico Norte	Conservación en las playas de anidación de tortugas marinas del sur de la peninsula de Nicoya, Costa Rica	Nesting female; monitoring, nest protection	1998	2020	Daniela Rojas-Cañizales/ Isabel Naranjo	Private	SINAC MINAE		RIESTER Foundation/ Rufford/ Volunteers Organizations	Daniela Rojas-Cañizales (drojas@cremacr.org)	Isabel Naranjo (inaranjo@cremacr.org)
T4.7	Ei (EPO)	América Central, Guanacaste, Pacífico Norte	Home range of hawksbill sea turtles as a conservation tool of Costa Rica	Monitoring, juvenile, hawksbill	2018	2020	Daniel Arauz / CREMA	Private	SINAC MINAE	www.sinac.go.cr	Sandler Family Foundation	Daniel Arauz darauz18@gmail.com	Randall Arauz (rarauz@finsattached.org
T4.8	CM-LO-DC-EI (EPO)	América Central, Osa Peninsula, Puntarenas; Pacífico Sur	Sea Turtle Conservation Program (Osa Conservation)	Nesting female, monitoring, nest protection, hatchery	2008	2020	Bárbara Sellés Ríos Marco Hidalgo	Private	SINAC ACOSA	https://drive.google.com/file/d/1S4J27XoMcnf02haSL3NHjofgem70Q1fL/view?usp=sharing https://drive.google.com/file/d/13fQIIP524KH0kMCqyUYALGZb7rtO2cSm/view?usp=sharing	Private donors and grants	Bárbara Sellés Ríos (seaturtles@osaconservation.org)	Marco Hidalgo (marcohidalgo@osaconservation.org)
T4.9	LO-EI (EPO)	América Central, Osa Peninsula, Puntarenas; Pacífico Sur	Proyecto Tortugas Preciosas de OSA	Nesting female, monitoring, nest protection, hatchery	2019	2021	Juan Carlos Cruz	Private				Juan Carlos Cruz (carloscruz@namaconservation.org)	
T4.10	CM-LO-DC-EI (EPO)	América Central, Guanacaste, Pacífico Norte	Conservation of sea turtles and restoration of the Pacific coastal ecosystem	Nesting female; monitoring, nest protection	2014	2020	Valerie Guthrie Benavides	Private	Sociedad Civil Proambiente Verdiazulcr	www.verdiazulcr.org	Volunteer program and private donors	Valerie Guthrie Benavides (valerie@verdiazulcr.org)	Daniel Arguedas Quesada (info@verdiazulcr.org)
T4.11	CM-LO-DC-EI (EPO)	América Central, Osa Peninsula, Puntarenas; Pacífico Sur	Proyecto de monitoreo y conservación de tortugas marinas en el Agua, Golfo Dulce, Costa Rica	Feeding grounds monitpring for hawksbill and greens	2008	2021	Didiher Chacón, Eduardo Altamirano, Luis Fonseca	Private	SINAC ACOSA	www.latinamericanseaturtles.com	JFF, Volunteers	Didiher Chacón, dchacon@latinamericanseaturtles.com	volunteers@latinamericanseaturtles.com
T4.12	LO (EPO)	América Central, Guanacaste, Pacífico Norte	Proyecto de monitoreo y conservación de tortugas marinas, Costa Rica	Monitoring, research, population, sea turtle, temperature	2014	2021	Roger Trejos Yaret Torres	Private	SINAC ACT	www.sinac.go.cr	Volunteer program and private donors	rtrejos@asvocr.org	
T4.13	CM-LO-DC (EPO)	América Central, Guanacaste, Pacífico Norte	Sea Turtle Conservation Program	Nesting female; monitoring, nest protection	2014	2020	Marc W. Ward/ Seaturtles Forever	Private	SINAC ACT	www.seaturtlesforever.org	Volunteer program private donors	marc@seaturtlesforever.org	N/A

Database available	Name of Database	Names of sites included (matching Table B, if appropriate)	Beginning of the time series	End of the time series	Track information Y/N	Nest information Y/N	Flipper tagging Y/N	Tags in STTI-ACCSTR? Y/N	PIT tagging Y/N	Remote tracking Y/N
Y	DB-Kuemar	Playas Nombre de Jesús, Minas, Onda, Playa Langosta	Dc: 1997/Cm:2006	ongoing	Y	Y	Y		Y	N
Y	TLT	Playa Grande, Ventanas, Cabuyal	DC:1993/Cm:2011	ongoing	Y	Y	Y for CM		Y	N
Y		Nancite, Naranjo	2010	ongoing	Y	Y	Y		Y	N
Y		Camaronal	2012	ongoing	Y	Y	Y		N	N
Y	DB-RPT	Playa Tortuga, Playa Hermosa de Uvita	2009	ongoing	y	y	y		N	N
Y		San Miguel, Costade Oro, Bejuco, Corozalito	1998	ongoing		Y	Y			
Y	DB-CREMA	Cabo Blanco	2018	ongoing	N	N	Y		N	N

Y	Sea Turtle Program Databases	Playas Piro, Pejeperro	2008	ongoing	Y	Y	Y	Y	Previously Y, Currently N	N
N	n/a	Playas Preciosa (Platanares), Colorada, Zapote, Tamales.	2019	ongoing	Y	Y	Y		N	N
N		Playa Junquillal	2001	ongoing	Y	Y	N	N	Y	N
y	n/a	Golfo Dulce	2008	ongoing	Y	n/a	Y	n	y	y
Y	n/a	Montezuma, Buena Vista, Ario	2014	ongoing	Y	Y	Y			N
Y	N/A	Playa Avellanas, Playa Lagartillo, Playa Callejones, Playa Blanca	2002	ongoing	Y	Y	Y	Y	N	N

Panamá

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General Remarks

The Pacific coast of Panama is an integral part of the Eastern Tropical Pacific Seascape and is comprised of two gulfs, the Gulf of Chiriquí and the Gulf of Panama, that are separated by the Azuero Peninsula. Five of the seven species of sea turtles are present in the tropical waters of Panama´s Pacific, including: leatherback *(Dermochelys coriacea),* green *(Chelonia mydas),* olive ridley *(Lepidochelys olivacea),* hawksbill *(Eretmochelys imbricata)*, and loggerhead *(Caretta caretta)*; although the latter is almost never seen and it is very likely that Panamanian waters are the southernmost limit of its distribution in the Eastern Pacific. In this seascape there are important coastal-marine ecosystems, inter-linked migration corridors, as well as critical habitats for sea turtles, such as mangrove forests, coral reefs, nesting beaches and seagrasses, among others. There are contrasting seasonal differences between the two gulfs; the Gulf of Panamá experiences a significant increase in productivity during the dry season/winter months from a well-defined coastal upwelling, resulting from the strong trade winds that make their way across the isthmus form the Caribbean, while the Gulf of Chiriqui is protected from these winds by the coastal mountain ranges that effectively limit the wind-driven upwelling effect[48]. Panama has multiple marine protected areas (MPAs) in the Pacific and among the most significant are Coiba National Park and the Las Perlas Archipelago Special Management Zone (ZEM), both of which contain abundant marine biodiversity.

Coiba National Park is the largest (270,125 ha) and most important of Panama´s marine protected areas and is forms an integral part of the Eastern Tropical Marine Corridor (CMAR)1; it is comprised of the 100km long Coiba Island and 38 smaller islands and surrounding marine areas within the Gulf of Chiriqui. Having served as a penal colony from 1919 to 2004 and then becoming a National Park and UNESCO Heritage site, its pristine ecosystems have been protected from large-scale commercial fishing for over a century. Protected from the cold winds and effects of El Niño, Coiba's Pacific tropical moist forest and relatively stable warm tropical waters help to maintain the largest extension of coral reefs (1700 ha) in the Eastern Tropical Pacific (ETPS)[15], making it an ideal refuge for various species of sea turtles, as well as providing a key ecological link

1 http://cmarpacifico.org/web-cmar/

for the transit, migration, and survival of various species of pelagic fish and marine mammals. The Las Perlas Archipelago is a series of over 250 islands located within the Gulf of Panamá, about 32 nautical miles from the coast and Panama City and was declared in 2007 as a Special Management Zone (ZEM). It is characterized by its rich biodiversity and fisheries resources; as well as, its various ecosystems, including coral reefs, which provide refuge for many species of megafauna, including sea turtles. The area is linked via the the North Equatorial Counter Current system to Colombia and Ecuador to the south[48].

Sea turtles in Panama have been fully protected by law and their capture and commercialization have been prohibited and penalized since 2008, when Panama formalized its commitments for the conservation and protection of sea turtles by officially ratifying the Inter-American Convention for the Protection and Conservation of Sea Turtles (CIT) through National Law No. 8 of January 4, 2008. Since then, Panama has continued to progressively implement a series of measures for the protection and conservation of sea turtles. Among these are the development of the Current State of Sea Turtles in Panama Assessment (2011) and the National Action Plan for the Conservation of Sea Turtles (2017-2021). More recently, civil society, government and other actors, have put forth and are actively promoting a legislative initiative for the establishment of a National Law for the "*Conservation and Protection of Sea Turtles and their Habitats in the Republic of Panama*."

Notwithstanding, much work still remains to be done, in particular in strengthening collaboration and synergies between government efforts and the various nesting beach projects carried out by community-based and/or conservation organizations. There are several nesting sites where monitoring and conservation efforts have been on-going for over a decade. On the Pacific side there are currently 9 different projects that are carried out independently by these local community-based organizations, that band together under the Panatortugas association2. Each of these, maintains its own records and receives varying degrees of support from other national conservation organizations, the private sector, development organizations or government, depending on their individual capacities or relationships with those entities. Recently, they have increased their collaborative efforts in order to standardize methodologies in data collection and to share their respective lessons learned.

Since the last administration, the Government of Panama, through the Ocean and Coasts Department (DICOMAR) of the Ministry of Environment, has increased overall efforts to improve research and monitoring capacities, collection of technical and scientific data, as well as advancing collaboration and information exchange at the regional level, with the aim of improving the overall management of sea turtle populations and their key habitats. At the same time, they have been actively fostering the inclusion, participation, interest, and commitment of as many key actors as possible,

2 https://panatortugas.org

including initiatives for generating socio-economic benefits in coastal and island communities (i.e., eco-tourism), that do not undermine sea turtle populations.

1. RMU Leatherback (*Dermochelys coriacea*) – Eastern Pacific

1.1. Distribution, abundance, trends

1.1.1. Nesting sites

There are sporadic reports in various beaches along the Pacific Coast of Panamá; however, these are mostly anecdotal and reports appear to decrease over time. Little has been recorded about the nesting of this species on the Pacific coast of Panama. Reports indicate there are no beaches that harbor significant numbers of nesting females[20], as is the case in Panama´s Caribbean coast; however, this is to be expected given the condition of its population in the Pacific. Some of the sporadic nesting beaches reported are in protected areas, such as La Barqueta Agrícola, RVS Isla de Cañas, Coiba National Park, as well as several other beaches on the west coast of the Azuero peninsula where there are anecdotal yet unconfirmed reports[50]. It is very likely that there are additional beaches with sporadic nesting may take place from time to time; for example, in the Las Perlas Archipelago, where historical nesting has taken place and where there are numerous somewhat recent anecdotal reports of in-water sightings by artisanal fishermen and/or local community members[55]. A recent 5-month beach monitoring effort in the Las Perlas Archipelago, which included structured interviews of community members, as well as artisanal fishermen, reported a significant percentage of the people interviewed having directly witnessed a leatherback nesting event or recall hearing second-hand accounts told by other community members[55]. In one instance in particular, there is a confirmed sighting of a leatherback nesting on Bayoneta beach in December of 2020[56].

1.1.2. Marine areas

Although all of Panama´s Pacific waters are encompassed in the ecological range of this species, its depleted numbers make them difficult to encounter anywhere in the Eastern Pacific. Notwithstanding, they are still incidentally caught by pelagic industrial fishing fleets from Mexico to Peru; however, no individuals of this species were incidentally caught by Panama´s long-line industrial fishing fleet throughout the entire period (2005 - 2010) that the IATTC, carried out their "*On-board monitoring program for the reduction of incidental bycatch of sea turtles in the long-line commercial fishery*" and circle-hook exchange program[6,21]. Nonetheless, there have been recent reports of in water sighting of sub-adult leatherbacks within the last few years in the Las Perlas Archipelago, where there are at least 10 anecdotal reports between 2019 and 2021 of direct observations or entanglements in artisanal fishing gear, with at least 2 of these incidents having been documented on video by the fishermen themselves[56]. Earlier this year, there is a report of a sub-adult leatherback in waters about 5nm off the southern coast of the Azuero peninsula, which was also filmed by a sports fishing tour operator[51].

1.2. Other biological data

At the end of the nesting season, individuals from Central America continue their migratory route towards deeper waters off the coasts of Panama, Colombia, Peru, Ecuador and Chile, where there are feeding areas and abundance of soft organisms like jellyfish.

1.3. Threats

1.3.1 Nesting areas

Over the last decade, there has been a significant and continuous increase in residential and touristic development projects along the of the Pacific coast of Panama. As in many places, beach development will inevitably impact potential nesting sites, in some cases before they may even be discovered or monitored, particularly in more remote areas that are not under federal protection. Due to their critical population status, the loss of any leatherback nest is considered an important threat. Nest predation can be carried out by human poaching, feral animals (e.g., dogs, pigs, etc.) or invasive species (i.e., coyotes). Sand extraction, both clandestine and permitted, also threatens nesting beach habitat in certain areas, in particular where development is increasing.

1.3.2. Marine areas

Although incidental capture is a serious threat for this species, there are no official reports of bycatch or entanglement the Panamanian long-ling fleet operating within the EEZ [21]; which is understandable when taking into account its low population numbers in the Pacific as a whole. Notwithstanding, and due to its critically endangered status, any mortality is a significant threat to the long-term survival of this population. There are anecdotal reports of somewhat recent sightings (most likely juveniles) by artisanal fishermen in the Las Perlas Archipelago, although no entanglements have been reported. Entanglement in lost (ghost) fishing gear, as well as plastic ingestion are considered to be an increasing occurrence and pervasive threat across most ocean habitats[45]; although related deaths probably go mostly unobserved and unreported. This is also the case in Panama where high levels of precipitation transport large quantities of plastic pollution down rivers, which then collect and are seen copiously drifting with other marine debris on the various currents that run along the pacific coast. TEDs are required on commercial shrimp trawlers; however, they are weakly enforced; while the long line fishery have traditionally used circle hooks, which have been shown to reduced entanglement and/or bycatch of sea turtles. Boats strikes could be a potential threat, but due to their low population numbers probably unlikely.

1.4. Conservation

Protected under national laws and international treaties such as CIT, CITES, CMS CBD, etc. Many of the beaches where nesting tracks have been observed are located within protected areas.

1.5. Research

Besides sporadic monitoring of beaches for potential nesting activity and some on-board observers that collect by-catch information in the long-line industrial fishing fleet there are no other research efforts at the moment for this species on the Pacific side of Panamá.

2. RMU: Green turtle (*Chelonia mydas*) – Eastern Pacific

2.1. Distribution, abundance, trends

2.1.1. Nesting sites

This species is the second most frequent nester in Panama´s Pacific coast after the olive ridley (*L. olivacea*). They often nest on the same beaches as olive ridleys and/or hawksbills in some cases; however, there seems to be specific beaches that are predominantly green turtle nesting sites. In terms of mayor nesting sites there are at least 18 recorded beaches, but the actual number is likely much higher. However, most turtle nesting beach conservation projects on Panama´s Pacific seem to focus on nesting sites that are predominantly olive ridley, perhaps because they happen to be more abundant overall. There are important green turtle nesting sites and foraging grounds for this species across Panama´s Pacific coast and its coastal and offshore islands, such as Coiba National Park and the Las Perlas Archipelago.

2.1.2. Marine areas

Their distribution across the Eastern Tropical Pacific Seascape (ETPS) has been well documented by both flipper tagging and satellite telemetry and individuals have been known to migrate freely between Mexico, Central America, the Galapagos Islands, Panama, Colombia, Ecuador, and as far south as Peru. In Panama, there appears to be key foraging grounds for this species in and around Coiba National Park, where both seagrass and coral reef habitat are abundant, easily available, and in good overall ecological condition.

2.2. Other biological data

More studies are necessary to generate information about the habitat use of green sea turtles in Panama and throughout the East Pacific.

2.3. Threats

2.3.1. Nesting sites

There are many negative anthropogenic impacts at key nesting sites including the development of residential and/or touristic infrastructure, poaching of eggs for local consumption and/or illegal trade, and the taking of nesting individuals for meat consumption. Destruction of nests by feral animals (e.g., dogs, pigs, etc.) or invasive species (i.e., coyotes) can also become a serious problem in certain areas that are near human developments. Recent monitoring in the Las Perlas Archipelago indicated increased erosion over the previous decade of potential key nesting sites[10], most likely due, to increased strength and frequency of storms as a result of climate change. Sand extraction, both clandestine and permitted, also threatens nesting beach habitat in certain areas, in particular where development is increasing; as do lights from human infrastructure that is near the beach.

2.3.2. Marine areas

Green turtles are the second most incidentally captured sea turtle in both, the long line industrial and artisanal fishing fleets[21,32]; but because they naturally feed in neritic habitats closer to the coast, they are much less prone to being caught by commercial long liners than olive ridley turtles. This proximity to the coastline, however, increases their chances being incidentally caught by shrimp trawlers or in artisanal long-lines and/or gill nets. Although TEDs are required on commercial shrimp trawlers, they are weakly enforced; while the commercial long-line fishery in Panama has traditionally used circle hooks[21], which have been shown to reduced entanglement and/or bycatch of sea turtles. Green sea turtles (as well as olive ridleys) are also incidentally caught in artisanal long-lines, with mortality increasing significantly with the use of bottom long-lines[32] since the turtles are unable to come to the surface and consequently drown. Entanglement in lost (ghost) fishing gear, as well as plastic ingestion are considered to be an increasing occurrence and pervasive threat across most ocean habitats[45]; this is also the case in Panama where high levels of precipitation transport large quantities of plastic pollution down rivers, which then collect and are seen copiously drifting with other marine debris on the various currents that run along the pacific coast. Boat strikes are probably somewhat common in coastal areas, but most likely do not represent a significant threat for the population.

2.4. Conservation

Protected under national laws and international treaties such as CIT, CITES, CMS CBD, etc. There are several nesting beach conservation projects on Panama´s Pacific coast, where there is monitoring of nesting females, hatcheries, and in some instances flipper tagging. In addition, preliminary reports indicate that it is likely that some of the most prolific nesting beaches for this species are found within protected areas, such as Coiba National Park.

2.5. Research

Currently, there are no active projects that focus research efforts on this species, besides the nesting beach conservation efforts where nests are counted and, in some cases, females are flipper tagged. However, there is a project that will soon start monitoring key green turtle nesting beaches within Coiba National Park.

3. RMU: Hawksbill turtle (*Eretmochelys imbricata*) – Eastern Pacific

3.1. Distribution, abundance, trends

3.1.1. Nesting sites

There are anecdotal and confirmed reports of limited nesting by hawksbill turtles in various beaches across Panama´s Pacific coast; however, there are only a handful of beaches that are actively monitored by local community-based conservation projects, some of which some have been active over the last decade or so. In the Pearl Islands Archipelago, a recent 5-month monitoring effort, which included structured interviews of both artisanal fishermen and community members, reported a significant percentage of people interviewed having observed directly nesting hawksbills[55]. On the whole, however, nesting numbers, number of nesting females, as well as nesting sites (both mayor and minor) are mostly unknown, unreported or understudied. The information collected through local monitoring efforts indicate overall low nesting numbers at any particular site (less than 20 nests per season); and although the peak reported season seems to be between June and September, there are reports of females sporadically nesting throughout the year[52].

Most reports of nesting hawksbills come from beaches from the western side of the Azuero Peninsula, which is one of the least developed coastlines and directly faces Coiba National Park in a straight-line distance of about 80 km (43 nm). Considering their documented natal foraging philopatric behaviour[11], as well as, previously established connections of tagged individual between nesting sites on the western side of Azuero and foraging areas in Coiba National Park[30, 52, 53], this coastline has become a key priority area for conducting further nesting-site surveys and eventually long-term monitoring initiatives. Interestingly, no nesting hawksbills or tracks have been observed within Coiba National Park, although *in situ* beach monitoring efforts have been sporadic or inconsistent at best, without a robust protocol over an entire season. In addition, hawksbills in Panamanian pacific waters may be nesting within estuary and mangrove habitat, as has been previously reported at other sites in Central America (Nicaragua and El Salvador)[46], which could make it more challenging to discover nesting sites and to monitor them. This suggests that is likely there are still undiscovered important nesting sites within Panama and in the EPO overall, which is consistent with recent genetic studies[12].

3.1.2. Marine areas

Although listed as critically endangered, hawksbill turtles are relatively common along the Pacific coast of Panama and are often seen around islands, rocky outcrops, or islets where coral aggregations are present. However, the highest recorded density for this species is within Coiba National Park[30], which holds the largest aggregations of coral reefs in the ETPS[15]. Moreover, the marine ecosystem around Coiba National Park is exceptionally healthy compared to other reefs in the region, as a result of being protected for over a century from large-scale commercial fishing; at first, indirectly, when it was employed as a penal colony (where boats were not allowed to come near the island due to potential aiding prisoners escape) and afterwards when it became a National Park and UNESCO Heritage site. The afforded long-term protection and consequent ecosystem health, in combination with plenty of space and food availability has allowed this hawksbill turtles (as well as greens and various other marine species) to thrive within its coastal waters.

Monitoring surveys since 2014 have been able to observe new recruits to the population each year, in particular within the smaller islands that are interspersed between the main island of Coiba and the continental coastline. This may indicate recruiting of juveniles to Coiba from other foraging sites or life-stages. Furthermore, in-water capture efforts over the last 7 years continue to maintain a ratio of about 1/1 of new individuals versus recaptured individuals[30], indicating, not only strong yearly recruitment, but also that the population at this foraging site may be in the thousands and is not close to reaching tag-saturation as of yet. These high hawksbill densities, together with strong indices of yearly recruitment, in most likelihood make Coiba National Park the most important foraging site for this species in the entire EPO and a key asset for population recovery at a regional level. Moreover, tag flipper data have shown adult females to migrate between nesting sites, in both, the Azuero Peninsula in Panama and the Osa Peninsula in Costa Rica, to foraging grounds in Coiba National Park[30]. In addition, connections between Colombia and Panamá have also been recorded, when an individual tagged in Colombia´s Gorgona National Park was found months later in the Pearl Islands Archipelago[49].

3.2. Other biological data

Size distribution range of captured individuals indicates that most hawksbills inside Coiba National Park are juveniles with most individuals in the 35 to 39 cm CCL size class, with a mean size of 43.3 cm and a range of 23cm – 77cm (CCL)[18, 30]. In-water capture-recapture efforts have indicated varying growth rates between different size classes, with smaller individual growing faster and then tapering off as they continue to age and grow bigger. Somatic growth rates3 of individual hawksbills ranged from -0.78 to 7.1 cm year^{-1}, with fastest growth rates recorded for turtles measuring 30.0-34.9 cm CCL and the slowest growth rates for hawksbills with CCL of 45.0- 49.9 cm.

3.3. Threats

3.3.1. Nesting sites

Anthropogenic impact on nesting sites (currently unknown or under studied) through development of residential and/or touristic infrastructure (which has significantly increased over the last decade), sacking of nests for local consumption or illegal trade, and the taking of nesting individuals for meat consumption. Destruction of nests by feral animals (e.g., dogs, pigs, etc.) or invasive species (i.e., coyotes) can also become a serious problem in certain sites that are near human developments. Recent monitoring in the Las Perlas Archipelago indicated increased erosion over the previous decade of potential key nesting sites[10], most likely as a result of increased strength and frequency of storms due to climate change. In addition, hawksbill shell has been traditionally used throughout Panama for the production of artisanal spurs used in cock fighting, a traditional activity throughout the country. Sand extraction, both clandestine and permitted, also threatens nesting beach habitat in some areas, in particular where development is increasing; as do lights from human infrastructure that are near the beach.

3.3.2. Marine areas

Hawksbill turtles are seldom incidentally captured by the long-line industrial and artisanal fishing fleets[21]. However, since they naturally feed in neritic habitats closer to the coastline, they are more at risk to being incidentally caught by shrimp trawlers or artisanal gill nets, the latter in particular within mangrove habitat and/or estuaries. Although TEDs are required on commercial shrimp trawlers, they are weakly enforced; while the long-line commercial fishery in Panama has traditionally used circle hooks[21], which have been shown to reduced entanglement and/or bycatch of sea turtles. Most hawksbill turtles that are caught by gill nets seem to be juveniles and are generally recovered alive and subsequently released[32]. Entanglement in lost (ghost) fishing gear, as well as plastic ingestion are considered to be an increasing occurrence and pervasive threat across most ocean habitats[45]; this is also the case in Panama where high levels of precipitation transport large quantities of plastic pollution down rivers, which then collect and are seen copiously drifting with other marine debris on the various currents

3 The numbers for this study need to be updated. At the time of its writing (2017), the number of recaptured hawksbill turtles was N = 51, whereas current sample size is at N = 386

that run along the pacific coast. Boat strikes are probably relatively common in coastal areas, but most likely do not represent a significant threat for the population.

3.4. Conservation

Protected under national laws and international treaties such as CIT, CITES, CMS CBD, etc. There are several nesting beaches conservation projects on Panama´s Pacific coast, where there is monitoring of nesting females, protection of nests through relocation into hatcheries, and in some instances flipper tagging. However, most of their nesting beaches, as well as nesting frequency, are unknown in Panama´s Pacific coast and thus more research is urgently needed in order to improve conservation efforts for this species in particular with increased coastal development. Although, nesting beaches are mostly unknown, potential nesting sites have been identified through monitoring surveys, interviews of local residents, and the implementation of the Nesting Beach Indicator Tool (NBIT)4.

3.5. Research

Ongoing in-water monitoring surveys of foraging grounds, including mark-recapture efforts have been carried out in Coiba Nation Park every 6 months since 2014, in order to assess population status, generate demographic data, and identify key foraging habitats and nesting sites. These efforts include in-water captures and processing of nearly 1000 individuals, including flipper and PIT tagging, biometrics, mark-recapture analysis, satellite tracking (for some adult individuals), as well as genetic and isotopes analysis. In terms of movements registered by satellite telemetry, to date, no satellite tagged turtles have left the immediate vicinity of Coiba Island; however, one individual relocated to the western side of the island for a short period of time (about 8 weeks) then returned to the original capture site and remained there until the tag stopped functioning. In addition, connections have been established via flipper tags between Coiba and the Azuero Peninsula in Panama and between Coiba and the Osa Peninsula in Costa Rica. Currently, there is an effort to collect blood samples for blood biochemistry analysis, with the aim to generate a reference baseline health profile of the population in Coiba National Park.

4. RMU: Olive ridley (*Lepidochelys olivacea*) – Eastern Pacific

4.1. Distribution, abundance, trends

4.1.1. Nesting sites

4 https://bluedotassociates.com/downloads/A_Sea_Turtle_Nesting_Beach_Indicator_Tool_Read_Me.pdf

Olive ridleys are the most abundant and prolific nesting species of sea turtle in the Eastern Tropical Pacific. In Panama´s Pacific they nest on beaches practically across the entire coast line, from the border from Costa Rica to the border with Colombia. There are over 60 beaches with confirmed nesting reported for this species (nearly 40 of them being mayor sites), although the actual number of nesting sites is likely twice that. Nesting beaches are found both inside and outside marine protected areas or special management zones (ZEMs). There are two sites where mass synchronous nesting (*"arribadas")* occurs, Isla Cañas and playa La Marinera, both of which are located in the Azuero Peninsula and are protected Wildlife Reserves. In Isla Cañas, however, egg harvesting (both permitted and illegal) takes place consistently throughout the entire nesting season. In 2013, nesting numbers at this site appeared to have crashed when the *arribada* failed to occur for the first time since records started in the 1990s. At first glance, it was believed that this may have been a direct result of uncontrolled egg-harvesting by the local community; since then, however, total annual nesting has, for the most part, remained consistent with previous counts from the 1990s of between 5000 – 12,000 nests per season. For example, between 2015 and 2019 the annual average was of 5818 nest per season. At playa La Marinera, annual nesting numbers do appear to indicate a downward trend (45,000 in 1996, 31,000 in 2000, and 21,000 in 2020); although nests are still in the tens of thousands, which is considerable for a beach that is only 600 meters wide.

4 1.1. Marine areas

Olive ridleys are widely distributed throughout Panama´s territorial waters on the Pacific. They migrate from nesting beaches to foraging grounds across several countries along the Eastern Pacific coast. Satellite tracking indicates random distribution patterns without clear migration routes. They can be found floating in the currents near the coastline and insular islands, while feeding on pelagic organisms. Recently, the creation of a regional management unit (RMU), including Costa Rica, Panama, and Colombia, has been suggested based on satellite telemetry of 34 tagged individuals and an observed high percentage of seasonal overlap with industrial fisheries in coastal and oceanic waters[47].

4.2. Other biological data

More studies are necessary to generate information about the habitat use of Olive ridley sea turtles in Panama.

4.3. Threats

4.3.1. Nesting sites

Anthropogenic impact of nesting sites through development of residential and/or touristic infrastructure has significantly increased over the last decade. Nest poaching for local consumption or illegal trade is still common practice in most areas of the Pacific, while the taking of nesting individuals for meat consumption is relatively rare or at least not common practice. Destruction of nests by feral animals (e.g., dogs, pigs, etc.) or invasive species (i.e., coyotes) can be a serious problem in certain areas that are near human development; for example, just a couple of feral pigs have been observed destroying dozens of nests that were deposited the previous night[10]. Recent monitoring in the Las Perlas Archipelago suggested increased erosion over the previous decade of potential key nesting sites[10], most likely as a result from increased strength and frequency of storms due to climate change. Sand extraction, both clandestine and permitted, also threatens nesting beach habitat in certain areas, in particular where development is increasing; as do lights from human infrastructure that is near the beach.

4.3.2. Marine areas

Olive ridley are widely distributed throughout the entire Eastern Pacific and are the most abundant of the sea turtle species that are present there. Their seemingly random distribution patterns have been shown to significantly overlap with industrial fishing grounds[47]. In Pacific Panama, they are the most incidentally captured sea turtle in both the long-line industrial and artisanal fishing fleets[21,32]. However, due to their relative high abundance they are also prone to being incidentally caught by commercial by shrimp trawlers or in artisanal long-lines. Although TEDs are required on commercial shrimp trawlers, they are weakly enforced; while the commercial long-line fishery in Panama has traditionally used circle hooks[21], which have been shown to reduced entanglement and/or bycatch of sea turtles. In artisanal fisheries mortality increased significantly with the use of bottom long-lines which are weighted[32] and where incidentally caught turtles are unable to come to the surface and consequently drown. Entanglement in lost (ghost) fishing gear, as well as plastic ingestion are considered to be an increasing occurrence and pervasive threat across most ocean habitats[45]; this is also the case in Panama where high levels of precipitation transport large quantities of plastic pollution down rivers, which then collect and are seen copiously drifting with other marine debris on the various currents that run along the pacific coast. Boat strikes are probably relatively common in coastal areas, but most likely do not represent a significant threat for the population.

4.4. Conservation

Protected under national laws and international treaties such as CIT, CITES, CMS CBD, etc. There are over a dozen nesting beaches conservation projects on Panama´s Pacific coast, some of these are run by the government and others by independent community-based organizations. At these project sites there is data collection on number of nests, eggs, and hatchlings, monitoring of nesting females, protection of nests through relocation into hatcheries and in some instances flipper tagging. In addition, some of the most prolific nesting beaches for this species are found within protected areas, such as Coiba National Park, playa La Marinera, and to some extent in Isla Cañas despite the serious poaching concerns cited above. Satellite telemetry of 34 olive ridleys tagged off of Panama´s Pacific coast traveled through nine different countries and international waters, with most locations occurring within Panama´s (60%) and Costa Rica´s (19.3%) EEZs, indicating the need for concerted and coordinated regional conservation efforts and perhaps the creation of a new RMU including Costa Rica, Panamá, and Colombia[47.]

4.5. Research

Currently, there are no active projects that focus research efforts on this species, besides nesting beach conservation efforts where nests are counted, protected in situ or relocated to hatcheries and, in some instances nesting females are flipper tagged.

5. RMU: Loggerhead (*Caretta caretta*) – Western Pacific

There is some confusion with regards to the presence of this species in Panama´s Pacific waters. Although there are some unconfirmed reports of loggerheads nesting on Panama´s pacific coast in the 1990s, most evidence points to inaccurate identification of individuals; most likely, because sea turtles in general are referred to as "*caguamas*" in many parts of Panamá[20], which is a common name used for loggerheads throughout LAC. Further supporting the argument of their absence in Panama´s Pacific, is that no individuals of this species were caught by the long-line industrial fishing fleet throughout the entire period (2005 - 2010) that Panama, in conjunction with the IATTC, carried out their "*On-board monitoring program for the reduction of incidental bycatch of sea turtles in the long-line commercial fishery*" and circle-hook exchange program[6,21]. Moreover, loggerheads are absent on the coasts of Colombia, Ecuador, Peru, and Costa Rica, making it highly unlikely that they would nest in Panama

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Table 1. Biological and conservation information about sea turtle Regional Management Units in Panamá.

RMU - Panama Pacific	Species: References							
Occurrence	**Lo**	Ref #	**Cm**	Ref #	**Ei**	Ref #	**Dc**	Ref #
Nesting sites	Y	*1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 19, 20, 24, 25, 27, 30, 50, 55*	Y	*1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 19, 20, 24, 25, 27, 30 50, 55*	Y	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 19, 20, 24, 25, 27, 30, 50, 55	Y	*1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 19, 20, 24, 25, 27, 55*
Pelagic foraging grounds	Y, JA, A	*6, 20, 29, 30, 31, 55*	Y, JA	*6, 20, 29, 30, 31*	Y, J		Y	*6, 20, 29, 30, 31, 51, 55, 56*
Benthic foraging grounds	Y		Y	*12, 14, 15, 18, 20, 29, 30*	Y	6, 12, 14, 15, 18, 20, 29, 30, 55	n/a	
Key biological data								
Nests/yr: recent average (range of years)	n/a		n/a		n/a		n/a	
Nests/yr: recent order of magnitude	n/a		n/a		n/a		n/a	
Number of "major" sites (>20 nests/yr AND >10 nests/km yr)	39		17		n/a		n/a	
Number of "minor" sites (<20 nests/yr OR <10 nests/km yr)	n/a		n/a		n/a		n/a	
Nests/yr at "major" sites: recent average (range of years)	n/a		n/a		n/a		n/a	
Nests/yr at "minor" sites: recent average (range of years)	n/a		n/a		n/a		n/a	
Total length of nesting sites (km)	290		290		n/a		n/a	
Nesting females / yr	n/a		n/a		n/a		n/a	
Nests / female season (N)	n/a		n/a		5	*20*	n/a	

Female remigration interval (yrs) (N)	n/a		n/a		2-3	*20*	n/a	
Sex ratio: Hatchlings (F / Tot) (N)	n/a		n/a		n/a		n/a	
Sex ratio: Immatures (F / Tot) (N)	n/a		n/a		n/a		n/a	
Sex ratio: Adults (F / Tot) (N)	n/a		n/a		n/a		n/a	
Avg. adult size, CCL or SCL (cm)	67.2	*1*	94.3- 95.6	*1, 33*	n/a		n/a	
Min adult size, CCL or SCL (cm)	n/a		n/a		n/a		n/a	
Age at maturity (yrs)	n/a		n/a		n/a		n/a	
Clutch size (n eggs) (N)	85 - 95	*1, 20, 33, 36, 43*	63	*1*	155	*20*	n/a	
Emergence success (hatchlings/egg) (N)	80%	*1, 33*	89% in situ	*1*	n/a		n/a	
Nesting success (Nests/ Tot emergence tracks) (N)	98%	*1*	n/a		n/a		n/a	
Trends								
Recent trends (last 20 yrs) at nesting sites (range of years)	n/a		n/a		n/a		n/a	
Recent trends (last 20 yrs) at foraging grounds (range of years)	n/a		n/a		n/a		n/a	
Oldest documented abundance: nests/yr (range of years)	La Marinera (arribadas) - *Lo* - 45,000 nests (1996), 38,000 nests (1999), 31,000 nests (2000), 21,000 nests (2020) - ***Decreasing*** Isla Cañas (1996) - Arribadas between 5000-12000 females - ***Stable*** - (2003 - 2009) - 7,786 avg. nests / (2015 - 2020) - 5,818 avg. nests Arribada failed in 2013 but stable trend over the years La Barqueta Agricola (1986-2003) - 2165 total nests (avg. 166 p/y) - 112 avg nests p/y (2016 - 2020) - Insuficiente data (effort not consitent) Mata Oscura (2008 - 2020) - 120-160 nests avg. p/y - ***Stable***							
Published studies								
Growth rates	n/a		n/a		Y	18	n/a	
Genetics	n/a		n/a		Y	11, 12	n/a	
Stocks defined by genetic markers	n/a		n/a		Y	12	n/a	
Remote tracking (satellite or other)	n/a		n/a		Y	30	n/a	

						(unpub.)		
Survival rates	n/a		n/a		N		n/a	
Population dynamics	n/a		n/a		N		n/a	
Foraging ecology (diet or isotopes)	n/a		n/a		N		n/a	
Capture-Mark-Recapture	n/a		n/a		Y	18	n/a	
Threats								
Bycatch: presence of small scale / artisanal fisheries?	Y (PLL, DLL)	32, 35	Y (PLL, DLL)	32, 35	Y (SN)	32, 35	n/a	
Bycatch: presence of industrial fisheries?	Y (PLL, ST, SN)	6, 21	Y (PLL, ST, SN)	6, 21	Y (PLL, ST, SN)	21	Y (PLL, SN)	21
Bycatch: quantified?	Y - Industrial PLL = CPUE 1.79 J-hook, 0.85 circle hooks with (*6) / 5.2 Lo per 1000 hooks (*21) / Artisanal DLL = 0.22 turtles /1000 hooks; Artisanal PLL = 1.18 turtles/1000 hooks (*32)	6, 21, 32, 35	Y - Industrial PLL = CPUE (per thousand hooks) 0.25 J-hook, 0.06 circle hooks (*6). / Artisanal DLL = 0.22 turtles/1000 hooks; artisanal PLL = 1.18 turtles/1000 hooks (*32)	6, 32, 35	Y (artisanal SN = 1 turtle in 83 sets. SN = 2 turtles in 250 sets CPUE = 0.012 turtles/set	35	n/a	
Take. Intentional killing or exploitation of turtles	Y		Y		Y		Y	
Take. Egg poaching	y		y		y		Y	
Coastal Development. Nesting habitat degradation	Y		Y		Y		Y	
Coastal Development. Photopollution	Y		Y		Y		Y	
Coastal Development. Boat strikes	Y		Y		Y		Y	
Egg predation	Y		Y		Y		Y	
Pollution (debris, chemical)	Y		Y		Y		Y	

Pathogens	n/a		n/a		n/a		n/a	
Climate change	Y	10	Y	10	Y	10	Y	10
Foraging habitat degradation	Y		Y		Y		Y	
Other	N							
Long-term projects								
Monitoring at nesting sites	Y		Y		n/a		N	
Number of index nesting sites	0		0		n/a		n/a	
Monitoring at foraging sites	N		N		Y	30	N	
Conservation								
Protection under national law	Y		Y		Y		Y	
Number of protected nesting sites (habitat preservation)	> 34		> 34		n/a		n/a	
Number of Marine Areas with mitigation of threats	3		3		3		n/a	
Long-term conservation projects (number)	10		10		2			
In-situ nest protection (egg cages)	13		13		2		n/a	
Hatcheries	Y		Y		Y		N	
Head-starting	N		N		N		N	
By-catch: fishing gear modifications (eg, TED, circle hooks)	Y (TED, circle hooks)	19	Y (TED, circle hooks)	19	Y (TED, circle hooks)	19	Y (TED, circle hooks)	19
By-catch: onboard best practices	Y		Y		Y		Y	
By-catch: spatio-temporal closures/reduction	N		N		N		N	
Other								

Note: Cc is mentioned in the literature, but no direct evidence found of sightings

Table 2. Sea turtle nesting beaches in Panamá.

Province	Beach	Protected Area	Species	Major Site	NGO presence	Available data	Nests/yr: (N) recent average (range of years)	Ref.	Central point		Beach Length (m)	% Monit.	Monit Level (1-2)	Monit Protocol (A-F)
Chiriqui	La Barqueta	RVS La Barqueta Agricola	Dc*, Cm, Lo, Ei	Y	N	<u>1986-2003</u> 77 females avg/yr 2165 Total nests 1004 females counted 77,132 turtles hatches from 87303 eggs 74 % Emergence success <u>2016</u> - 38 nests <u>2017</u> - 41 nests <u>2018</u> - 21 nests <u>2019</u> - 80 nests <u>2020</u> - 383 nests - at least one Ei	N =166 (1986-2003) species not spec., but other data indicate mainly *Lo* N = 112 (2016 - 2020) mainly Lo - Monitoring effort does not seem consistent	23, 37, 54	8.300792	-82.570711	14,000		disc.	disc.
Chiriqui	Isla Sevilla	AP Manglares de David	Lo	S/D	N			20	8.232063°	- 82.403414°	8,400			
Chiriqui	Playa Grande (Isla Parida)	PNM Golfo de Chiriquí	Dc*, Cm, Ei, Lo	S/D	N			20, 23	8.098815°	- 82.358977°	950			
Chiriqui	Islas Paridas	PNM Golfo de Chiriquí	Cm, Lo	S/D	N	Multiple beaches within these group of islands		7	8.098482°	- 82.359024°				
Chiriqui	Boca Vieja	RVS Boca Vieja	Cm, Lo	S/D	N			20	8.154108	-81.821376	5,200			
Chiriqui	Playa La Barqueta (fuera del RVS)		Lo, Cm	Y	Y	<u>2019</u> (Jun - Nov) N = 74 - Lo and 1 - Cm 5,000 hatchlings / 82% emergence success / estimated eggs 6097 / avg. clutch size 81 <u>2020</u> 105 nests	N = 90	33, 34, 54	8.306512°	- 82.589593°	0	35% (5km) (residential zone) Jun-Nov	2	B
Chiriqui	Isla Boca Brava		S/D	S/D	N			20	8.201550°	- 82.295676°	8100			
Chiriqui	Bajo Pipón		S/D	S/D	N			20	8.275268°	- 82.436613°	2500			
Chiriqui	El Bongo		S/D	S/D	N			20	8.234997°	- 82.343407°	5400			
Chiriqui	Resbalosa		S/D	S/D	N			20	n/a	n/a				
Chiriqui	Punta Burica		S/D	S/D	N			20	8.030334°	- 82.875386°	700			

Veraguas	Damas	PN Coiba	S/D	S/D	N			20	7.528751°	- 81.677143°	1600			
Veraguas	EL María	PN Coiba	S/D	S/D	N			20	7.412160°	- 81.701498°	700			
Veraguas	Playa Blanca	PN Coiba	Cm, Lo	Y	N	*importance of site based on direct observation*	> 20	20, 30	7.38575	-81.664583	1000			
Veraguas	Río Amarillo	PN Coiba	Cm, Lo	Y	N	*importance of site based on direct observation*	> 20	20, 30	7.385085	-81.622936	1000			
Veraguas	Anegada	PN Coiba	S/D	P	N			20	7.345905°	- 81.603847°	2500			
Veraguas	Isla Jicarón	PN Coiba	Cm	P	N	*importance of site based on direct observation*	> 20	20, 30	7.287664°	- 81.785072°	4000			
Veraguas	Barco Quebrado	PN Coiba	Dc*, Cm	Y	N	*importance of site based on direct observation*	> 20	20, 30	7.33461	-81.683145	4100			
Veraguas	Manila	PN Coiba	Dc*, Cm, Lo, Ei	Y	N	*importance of site based on direct observation*	> 20	20, 30	7.34748	-81.741045	8000			
Veraguas	Santa Clara	PN Coiba	S/D	S/D	N			20	7.465673°	- 81.864758°	600			
Veraguas	Playa Hermosa	PN Coiba	S/D	Y	N	*importance of site based on direct observation*	> 20	20, 30	7.521965°	- 81.858985°	2500			
Veraguas	Playa Brava	PN Coiba	S/D	Y	N	*importance of site based on direct observation*	> 20	20, 30	7.552873°	- 81.842585°	2300			
Veraguas	Isla Santa Catalina		Ei, Lo	S/D	N			20	7.622290°	- 81.272437°	350			
Veraguas	El Flor		Cm	S/D	N			20	7.656444°	- 81.321816°	750			
Veraguas	Isla Cebaco - Playa Grande		S/D	S/D	N			20	7.541957°	- 81.105547°	3800			
Veraguas	Malena		Dc*, Cm Lo, Ei	Y	Y	<u>2020</u> 389 nests 35,661 eggs - Lo (87% hatching successs) Cm - 300 hatchlings reaeased (6 nests)	Lo - 300 Cm - 6 in 2020	17, 54	7.576357	-80.966848	2500	100	2	B
Veraguas	Torio		S/D	Y	N			20	7.550980,	-80.950171	1500			
Veraguas	Morrillo		Cm, Lo, Ei	P	P			20	7.490561	-80.954474	2100			
Veraguas	Mata Oscura		Dc*, Cm, Lo, Ei	Y	Y	N = 120-160 nests avg. per year 89 - 92% emergence rate 200,000 hatchlings released since 2008 - (14K - 16K per year) Ei - 1200-1600 hawksbill hatchlings per year	120-160 -(Lo, Cm) 15-20 - Ei	2, 16, 20, 30, 33, 41, 43	7.454355	-80.923401	4400	100	1	B

						2019 - 2020 (jun - jun) Lo - 184 nests: 129 relocated, 55 poached (30%) 129 observed females Cm - 10 nests, 6 relocated and 4 poached (40%) 6 observed females Ei - 4 nests: 2 relocated and 2 poached (50%) 2 observed females								
Veraguas	Plaza		Dc*, Lo	S/D	N			2	7.411454,	-80.930664	1100			
Veraguas	Playa Blanca		Lo	S/D	N			2	n/a	n/a				
Veraguas	Cascajilloso (el Cacao, Arenas)		Dc*, Cm, Lo, Ei	Y	N	Site of major activity of Lo, CM and Ei with sporadic monitoring by PN Cerro Hoya personnel on four wheeler or motor bike. -Nursery set up in 2019 Ei - observed nesting somewhat regularly 2019-2020 89 nests relocated / 5,953 hatchlings released -at least one Ei 2020-2021 around 100 nests (Lo and Cm) - at least two Ei	N = 100 (estimated) Mainly *Lo*	2, 20, 30, 33	7.366918	-80.90146	8800	100	2	B
Veraguas	Sandial		Dc*, Cm	S/D	N			2, 30, 50	n/a	n/a				
Veraguas	El Gato		Cm, Lo, Ei	Y	N			2, 30, 50	7.309076	-80.920422	650			
Veraguas	Varadero		Lo	S/D	N			2, 30, 50	7.289764	-80.924341	1240			
Veraguas	Naranjo		Lo	P	N			2, 30, 50	7.274560°	- 80.922099°	900			
Veraguas	Restinguito		Lo*	S/D	N			2, 20, 30, 50	7.222341°	- 80.886913°	500			
Veraguas	Restingue		Dc*, Lo	S/D	N			2, 20, 30, 50	7.239314°	- 80.900217°	550			
Veraguas	Colorado		Lo	S/D	N			20	7.212991°	- 80.835802°	250			
Veraguas	Coloradito		Lo	S/D	N			20	7.214159°	- 80.826414°	800			
Veraguas	La Ventana		Lo	S/D	N			20	7.207880°	- 80.793433°	460			

Veraguas	Piro		Lo	S/D	N			20	7.213822°	-80.756569°	1000			
Veraguas	Sierra		Lo	S/D	N			20	7.211054°	-80.722049°	900			
Veraguas	Cobachón		Lo	S/D	N			20	7.232870°	-80.620200°	700			
Veraguas	La Enjarma		Lo	S/D	N			2	n/a	n/a				
Los Santos	Punta Blanca		Lo	S/D	N			20	7.234157°	-80.588231°	1300			
Los Santos	Pedregal		Lo	S/D	N			20	7.243188°	-80.562285°	200			
Los Santos	Horcones		Lo	S/D	N			20	7.242711°	-80.542714°	3200			
Los Santos	Los Buzos		Lo	S/D	N			20	7.250272°	-80.505764°	1000			
Los Santos	Cambutal y La Cuchilla ^		Lo, Cm, Ei	Y	Y	2014-2015 592 *Lo* nests (40% poached / 98% nesting success) Avg. clutch size = 95 / CCL = 67.2cm / CCW = 70.5cm Emergence success varies: 85% (wet) y 72% (dry) 2019-2020 553 *Lo* elocated nests / 50,655 eggs / 42,616 hatchlings released / Hatching success - 84.89% / Emergence succes - 80.17%.	2014 - 2020 588 - Lo 3.2 - Cm 0.5 - Ei	1, 20, 33, 38,	7.248891°	-80.483502°	4000	100	2	B
Los Santos	Morro de Puerco		Lo	S/D	N			20	7.244855°	-80.449801°	1500			
Los Santos	La Marinera [A]	RVS La Marinera	Lo	Y	Y	(*Arribadas)* - 20,000 females in 1997 - 38,200 nests in 1999 - 15,000 females registered (2009 -2012), but estimates range b/w 30K - 50K - 40,000 females in 2012 (7,000 in one day) - 45,000 females in 2013 - 5,000 females in 2014 (trend decreasing) - 31,000 nests in 2020	N/A - data appears inconsistent (sometimes reported as females, others as nests)	20, 23, 33	7.256678°	-80.426837°	500	100	2	B
Los Santos	Guanico abajo		Lo	Y		Arribadas (tortuguias website, but mostly likely refers to La Marinera)		20	7.273922°	-80.412738°	3900			

Los Santos	Ostional		Lo	S/D				20	7.310931°	-80.381528°	9000			
Los Santos	Isla Cañas [A]	RVS Isla Cañas	Dc*, Cm, Lo, Ei	Y	Y	<u>2003 - 2009</u> (*Arribadas*) 2003 - 5,798 females 2004 - 5,069 females 2005 - 6,651 females 2006 - 8,760 females 2007 - 6,308 females 2008 - 15,115 females 2009 - 6,606 females Arribadas in the past - 5000-12000 tortugas (Evans y Vargas, 1996) - decrasing trend reported in the last decade (2013 first year no arribadas), likely due to illegal harvesting/consumption (Comer Santos-2014) <u>2015 - 2016</u> - 3553 nests <u>2016 - 2017</u> - 4345 nests <u>2017 - 2018</u> - 4966 nests <u>2018 - 2019</u> - 6500 nests <u>2019 - 2020</u> - 9725 nests / 1230 poached (13%) / Tracks 18,225 (53% nesting success) 60,350 eggs / 80% emergence success (49,097 hatchlings released) / 85% hatching succes (2,268 dead hatchlings, *does not mentioned eggs not hatched) - 314 tagged turtles b/w 2014 - 2019	Trend seems stable within historical range of nests per year 5000 -1200 Avg. nests per year - (2003 - 2009) = 7,786 (2015 - 2020) - 5,818	19, 20, 33, 40	7.407991°	-80.318165°	14000	40% (6km)	2	B
Los Santos	Madroño		Lo	S/D	N			20	7.423376°	-80.237765°	2000			
Los Santos	Venao		Lo	S/D	N			20	7.432098°	-80.194514°	3000			
Los Santos	Oria		Lo	S/D	N			20	7.431113°	-80.113591°	2700			
Los Santos	La Miel	Reserva Ecologica Los Panamaes	Lo, Cm	Y	Y	*Note: Data reported together for the 3 beaches* <u>2019 - 2020 (Jun-Mar)</u>		33	7.435923°	-80.085644°	1100	100	2	B

Los Santos	Los Panamaes					Nests = 138, (Lo - 128, Cm - 10) Tracks = 198 (Lo - 168, 25 - Cm) Nesting success (76% Lo, 40% - Cm) Poaching (17% or 23 nests) - 101 relocated nests, 14 *in situ* - 9,307 eggs / 8,038 hatchlings released - 87.1% hatching success - 86.3 % emergence succes		33	7.441286°	- 80.076640°	1000	100	2	B
Los Santos	Puerto Escondido							33	7.444382°	- 80.069916°	500	100	2	B
Los Santos	El Tigre	RVS Pablo Arturo Barrios	Lo, Ei	Y	Y	> 20 nests per month		39	7.611509°	- 80.040134°	5000	100	2	B
Los Santos	Rincón (Mariabe)	RVS Pablo Arturo Barrios	Lo	Y	Y	> 20 nests per month		39	7.580535°	- 80.029658°	200	100	2	B
Los Santos	El Arenal	RVS Pablo Arturo Barrios	Lo	S/D	Y			20, 33	7.551721°	- 80.012147°	3500	100	2	B
Los Santos	Toro	RVS Pablo Arturo Barrios	Lo	Y	Y			20, 33	7.533934°	- 80.003406°	2000	100	2	B
Los Santos	La Garita	RVS Pablo Arturo Barrios	Lo	Y	Y	> 20 nests per month		33, 39	7.512450°	- 79.993072°	300	100	2	B
Los Santos	Lagarto	RVS Pablo Arturo Barrios	Lo, Cm	Y	Y	<u>2016 - 2017 (ago-feb)</u> Nests = Lo - 11, Cm - 4 / 75% of nests poached/depredated		20, 36	7.507340°	- 79.999033°	1300	100	2	B
Los Santos	Lanchon	RVS Pablo Arturo Barrios	Lo, Cm	P	N			33	7.490657°	- 79.999495°	1400	0	n/a	n/a
Los Santos	El Rompío	Reserva Forestal Maritima Santa Ana	S/D	S/D	N			2	7.971894°	- 80.342323°	1750			
Los Santos	Albina Grande		S/D	S/D	N			20	7.884277°	- 80.298819°	5000			
Los Santos	Bella Vista		S/D	S/D	N			20	7.843542°	- 80.256089°	8000			
Los Santos	El Crial	RVS Isla Iguana	Ei, Lo	S/D	N			2	7.626913°	- 79.999760°	370	100	2	B
Coclé	Los Azules		S/D	S/D	N			20	8.298267°	- 80.308594°	12500			
Coclé	Playa Blanca		S/D	S/D	N			20	8.345184°	-	25000			

										80.153996°				
Coclé	Farallón		S/D	S/D	N			20	8.359760°	- 80.131750°	3000			
Panama	Punta Chame		Lo	Y	Y	<u>2014-2015</u> 87 <u>2015-2016</u> 94 <u>2016-2017</u> 116 <u>2017-2018</u> 259 <u>2018-2019</u> 233 <u>2019-2020</u> 172	N = 166 (*Lo*)	33	8.620614°	- 79.732777°	13000			B
Panama	Bancos de Chame		Lo	S/D	N			20	8.572749°	- 79.795961°	8300			
Panama	Punta Culebra		S/D	N	N			20	8.913029°	- 79.529351°	170			
Panama	Isla Taboga	RVS Taboga	Lo	N	N			20	8.800867°	- 79.554767°	900			
Panama	Floral, Isla del Rey	ZEM Las Perlas	Cm, Lo	S/D	N			1, 8, 10, 20,	8.405063°	- 78.964615°	800			
Panama	Martín Perez, Isla del Rey	ZEM Las Perlas	Cm, Lo	S/D	N			1, 8, 10, 20,	8.382422°	- 78.961811°	1000			
Panama	La Legua, Isla del Rey	ZEM Las Perlas	Cm, Lo	S/D	N			1, 8, 10, 20,	8.355543°	- 78.959259°	3700			
Panama	Río Sucio, Isla del Rey	ZEM Las Perlas	Cm, Lo	S/D	N			1, 8, 10, 20,	8.314662°	- 78.964331°	820			
Panama	Otonal (Atajo), Isla del Rey	ZEM Las Perlas	Cm, Lo	S/D	N	<u>2019-2020</u> (Oct - Mar) Lo – 13, Cm – 4, Ei‡ – 7		1, 8, 10, 20, 55, 56	8.299996°	- 78.966374°	1300			B
Panama	Barquito, Isla del Rey	ZEM Las Perlas	Cm, Lo	S/D	N	<u>2019-2020</u> (Oct - Mar) Lo – 6, Cm – 1, Ei‡ - 2		1, 8, 10, 20, 55, 56	8.293436°	- 78.959908°	900			B
Panama	Grillo, Isla del Rey	ZEM Las Perlas	Cm, Lo	Y	N	<u>2019-2020</u> (Oct - Mar) Lo – 37, Cm – 8, Ei‡ - 4		1, 8, 10, 20, 55, 56	8.283653°	- 78.941738°	3500			B
Panama	Playón (Playa Grande), Isla del Rey	ZEM Las Perlas	Cm, Lo, Ei	Y	N	<u>2014-2015</u> 26 Cm nests between jan - may / 90% (in situ) hatiching success / avg. Clutch size 63 <u>2019-2020</u> (Oct - Mar) Lo – 26, Cm – 18		1, 8, 10, 20, 55, 56	8.231463°	- 78.920933°	800	n/a discont inued	2	B
Panama	Laguna de la Yeya, Isla del Rey	ZEM Las Perlas	Cm, Lo	Y	N	<u>2019-2020</u> (Oct - Mar) Lo – 21, Cm – 2,		1, 8, 10, 20, 55, 56	8.226340°	- 78.913646°	750			B
Panama	Punta Coco Norte, Isla del Rey	ZEM Las Perlas	Cm, Lo	S/D	N			1, 8, 10, 20,	8.228254°	- 78.904314°	1000			
Panama	Punta Coco Este, Isla del	ZEM Las Perlas	Cm, Lo	S/D	N			1, 8, 10, 20,	8.226535°	- 78.897539°	200			

	Rey													
Panama	Punta Coco Sur, Isla del Rey	ZEM Las Perlas	Cm, Lo	S/D	N			1, 8, 10, 20,	8.222982°	- 78.902750°	400			
Panama	Playa Brazo (Tortuguera y Nispero), Isla del Rey	ZEM Las Perlas	Cm, Lo	Y	N	<u>2014 - 2015</u> 61 Lo nests Agosto - Febrero / hatching success 73% relocation / avg. clutch size 95 <u>2019-2020</u> Lo – 9, Cm – 8		1, 8, 10, 20, 55, 56	8.239158°	- 78.911259°	2000	n/a discont inued	2	B
Panama	Mafafita, Isla del Rey	ZEM Las Perlas	Cm, Lo	S/D	N			1, 8, 20, 55,	8.284964°	- 78.920408°	600			
Panama	Limón, Isla del Rey	ZEM Las Perlas	Cm, Lo	S/D	N			1, 8, 20,	8.290582°	- 78.917683°	250			
Panama	Cacique, Isla del Rey	ZEM Las Perlas	Cm, Lo	S/D	N			1, 8, 20,	8.307557°	- 78.899881°	1000			
Panama	Prieta, Isla del Rey	ZEM Las Perlas	Cm, Lo	S/D	N			1, 10, 20,	8.299929°	- 78.890732°	870			
Panama	Cinique, Isla del Rey	ZEM Las Perlas	Cm, Lo	S/D	N			1, 8, 10, 20,	8.300305°	- 78.875318°	800			
Panama	Chiquero, Isla del Rey	ZEM Las Perlas	Cm, Lo	S/D	N			1, 8, 10, 20,	8.295536°	- 78.857277°	1700			
Panama	San Juan, Isla del Rey	ZEM Las Perlas	Cm, Lo	Y	N			1, 10, 20,	8.313651°	- 78.851682°	2250			
Panama	Punta Gorda	ZEM Las Perlas	Cm, Lo	S/D	N			8, 20	8.340027°	- 78.840579°	700			
Panama	Ensenada Playa Grande, Isla de San Jose	ZEM Las Perlas	Cm, Lo	Y	N			8, 10, 20,	8.251678°	- 79.104446°	1800			
Panama	Playa Brava, Isla Pedro Gonzales	ZEM Las Perlas	Cm, Lo	Y	N			8, 10, 20, 55, 56	8.399503°	- 79.117176°	480			
Panama	Playa Blanca, Isla Pedro Gonzalez	ZEM Las Perlas	Cm, Lo	Y	N			8, 10, 20, 55, 56	8.391985°	- 79.113993°	250			
Panama	Playa Galera, Isla Pedro Gonzalez	ZEM Las Perlas	Cm, Lo	S/D	N			8, 10, 20, 55, 56	8.381789°	- 79.095554°	450			
Panama	Playa Principal, Isla Viveros	ZEM Las Perlas	Cm, Lo	N	N			8, 10, 20, 55, 56	8.488914°	- 78.978355°	600			
Panama	Playas al Oeste, Isla Bayoneta ^	ZEM Las Perlas	Dc*, Cm, Lo, Ei	Y	N			8, 10, 20, 55, 56	8.488762°	- 79.066681°	1700			

Panama	Playa oeste, Isla Gibraleon	ZEM Las Perlas	Cm, Lo	S/D	N			8, 10, 20,	8.516191°	-79.047870°	950			
Panama	Isla Chapera ^	ZEM Las Perlas	S/D	S/D	N			8, 10, 20,	8.589391°	-79.027425°	1600			
Panama	Isla Mogo Mogo ^	ZEM Las Perlas	S/D	S/D	N			8, 10, 20,	8.574920°	-79.025428°	900			
Panama	Playa larga, Isla Saboga	ZEM Las Perlas	Lo	S/D	N			8, 10, 20,	8.615581°	-79.065688°	500			
Panama	Playa Blanca, Isla Saboga	ZEM Las Perlas	Lo						8.632990°	-79.066336°	200			
Darien	Playa Muerto		Lo, Ei	Y	Y	<u>2015</u> 36 - Lo and 1 - Ei (Sept 29 and Nov 20) 79% hatching success 2015. CCL range 60 to 75 cm, 80% between 60 and 67cm		16	7.886672°	-78.360253°	1250	100	2	B
Darien	Jaque		Lo, Cm	Y	Y	<u>2012 - 2020 - Nests (N)</u> 140 - 2012 154 - 2014 271 - 2015 182 - 2016 517 - 2017 376 - 2018 183 - 2019 220 - 2020 (168 relocated, 52 in situ) - 73% emergence success - 80,000 hatchlings released between 2013-2020	255 (2013-2020)	33, 43	7.503672°	-78.145519°	5600	100	2	B
Darien	Punta Patiño (Playas Brava, Patiño, y Machete) ^	Punta Patiño (humeda interna-cional)	Dc*, Lo, Ei	Y	Y			5	8.290527°	-78.262513°	1200			

<u>NOTES:</u>

Highlighed items indicate presence of monitoring project on that beach
A = arribada

^ = beaches monitored together or grouped in a certain area
** = anectdotal evidence*

‡ = potential nests

P (in Major site column) = high probability

S/D = no data available

Table 3. International conventions protecting sea turtles and signed by Panamá.

International Conventions	Signed	Binding	Compliance measured and reported	Species	Conservation actions	Relevance to sea turtles
CITES (Convención sobre el Comercio Internacional de Especies Amenazadas)	Y	Y	Y	ALL	Illegal trade of sea turtles, their eggs, or parts are subject to penalties, fines, and/or encarcerations under national law.	Prohibits international trade and commerce of sea turtles or their parts.
CBD (Convenio sobre la Diversidad Biológica)	Y	Y	Y	ALL	The Republic of Panama has established monitoring programs, implemented conservation actions and policies, as well a National Actions Plan for the protection, conservation, and restoration of sea turtles and their habitats.	To promote the conservation of biological diversity, ensure the sustainable use of the components of biological diversity, and to promote the fair and equitable sharing of the benefits resulting from the utilization of genetic resources.
CIT (Convención Interamericana para la Protección y Conservación de las Tortugas Marinas)	Y	Y	Y	ALL	Prohibit intentional killing and trade of sea turtles, conservation, and restoriation of sea turtle habitats and nesting areas, establishing restrictions such as protected areas, promoting scientific research, environmental education and collaboration between government, NGOs, communities, as well as reduce incidental bycatch and mortality of sea turtles through appropriate regulation of fishing activities.	Promotes the protection, conservation, and recovery of the populations of sea turtles and those habitats on which they depend, on the basis of the best available data and taking into consideration the environmental, socioeconomic and cultural characteristics of the Parties (Article II, Text of the Convention). These actions should cover both nesting beaches and the Parties' territorial waters.
IATTC (Convención Interamericana de Atún Tropical)	Y	Y	Y	ALL	The Republic of Panama has activelty participated in research and statistical collection programs, such as the circle hook trial and exchange program, with the aim of improving managmenta and regulation of industrial fisheries, including the implementation of good practices for the reduction of incidental bycatch of sea turtles.	The IATTC is responsible for the conservation and management of tuna and other marine resources in the eastern Pacific Ocean, including keepings statistics of bycatch intertactions with sea turtles and developing better practices and implementing recommendations to minimize byctach, as well as regulating IUU fishing.
CMS - Convención de Especies Migratorias	Y	Y	Y	ALL	Protection of sea turtles and their habitats at the national and regional level	CMS provides a global platform for the conservation and sustainable use of migratory animals and their habitats. CMS brings together the States through which migratory animals pass, the Range States, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range.

UNCLOS (Convención de las Naciones Unidas sobre el Derecho del Mar)	Y	Y	n/a	ALL	Protection of sea turtles and their habitats at the national and regional level	UNCLOS calls upon the coastal States and other States fishing highly migratory species to cooperate in ensuring conservation and promoting the optimum utilization of those resources in their whole area of distribution.
FAO Fisheries Code of Conduct	Y	Y	Y	ALL	Panama regulates commercial fishing practices within national waters, such as in the implementation of circle hooks in Pelagic Long Line fisheries or use of TEDs in commercial Shrimp Trawls.	Sets international standards of behaviour for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity.
SICS-OSPESCA	Y	Y	y	ALL	Impulsar las estrategias de la Política de Integración de Pesca y Acuicultura; Promover y dar seguimiento al Tratado Marco Regional de Pesca y Acuicultura; Coordinar esfuerzos interinstitucionales e intersectoriales de alcance regional para el Desarrollo pesquero centroamericano, con un enfoque ecosistémico e interdisciplinario; Aunar esfuerzos para armonizar y aplicar las legislaciones de pesca y acuicultura; Formular e impulsar estrategias, programas, proyectos, acuerdos o convenios regionales de pesca y acuicultura.	Concertar y promover un modelo de desarrollo regional armónico y sostenible de la pesca y la acuicultura, que garantice la obtención de máximos beneficios sociales y económicos para la población centroamericana.

Table 4. Projects and databases on sea turtles in Panamá.

Organizations on the ground	type	primary species	primary beaches	work carried out	Long term >5 years	start date
Dirección de Costas y Mares (**DICOMAR**) – Departamento de Manejo de Recursos Costeros y Marinos, Ministerio de Ambiente	Government in conjunction with other local and/or international organizations	*Lo*	RVS Isla Cañas	Monitoreo, Vivero	Y	2012
		Lo	Reserva Biológica Playa La Marinera	Monitoreo, Vivero, marcaje,	Y	2009
		Lo, Cm, Ei	Playa Cascajilloso	Monitoreo, Vivero, marcaje,	N	2019
		Lo, Ei	RVS La Barqueta Agrícola	Monitoreo, Vivero	Y	2010
		Ei, Dc	Beaches and foraging grounds of Coiba National Park and its area of influence **Note: This an international collaborative research effort in conjunction with: SENACYT, NOAA, ICAPO, WWF Colombia, and Fundación Eco-Mayto (México).*	In water monitoring, research, mark-recapture, flipper tags/PITs, satellite tracking, genetics, isotopes	Y	2014
Panatortugas - network of 14 sea turtle conservation organization/proyects in Panama (8 - Pacific and 6 - Caribbean)	Network of local conservation projects	*Lo, Cm, Ei, Dc*	n/a	Network support and knowledge managment	n/a	2012
Fundación Tortuguías	NGO	*Lo, Cm, Ei*	Cambutal, La Cuchilla, Punta Chame	Monitoring, nursery, flipper tags	Y	
ACOTMAR - Agrupacion en Pro de la Conservacion de las Tortugas Marinas	NGO/Academia	*Lo, Cm*	La Barqueta, (fuera de la RVS)	Monitoring, nursery, flipper tags	N	2019
FUNDAT - Fundación Agua y Tierra	NGO	*Lo, Cm, Ei*	Mata Oscura	Monitoring, nursery, flipper tags, nocturnal drone w/ thermal camera	Y	2012
ACOPLAMA - Asociación Conservacionesta de tortugas marinas de Playa Malena	Organización de Base Comunitaria	*Lo, Cm*	Playa Malena	Monitoring, nursery,	Y	2002
Reserva Ecologica Privada Los Panamaes	Privada	*Lo, Cm*	Los Panamaes, Puerto Escondido y La Miel	Monitoring, nursery, flipper tags	Y	2015
Tortugas Pedasi	NGO	*Lo, Cm*	Playas de la RVS Pablo Arturo Barrios (5)	Monitoring, nursery, flipper tags	Y	2012

Organización protectora de la tortuga marina y la biodiversidad de Jaque	Organización de Base Comunitaria	*Lo*	Playa Jaque	Monitoring, nursery, flipper tags	Y	1998
TORTUAGRO (Grupo para la Conservación de las Tortugas Marinas, Desarrollo del Turismo y Sector Agropecuario de Cambutal)	Organización de Base Comunitaria	*Lo, Cm, Ei*	Cambutal y La Cuchilla	Monitoring, nursery, flipper tags	Y	2010
Comité Ambiental de Alanje	Organización de Base Comunitaria	*Lo, Cm*	RVS La Barqueta Agricola	Monitoring, nursery **Note: project no longer active*	n/a	1986-2005

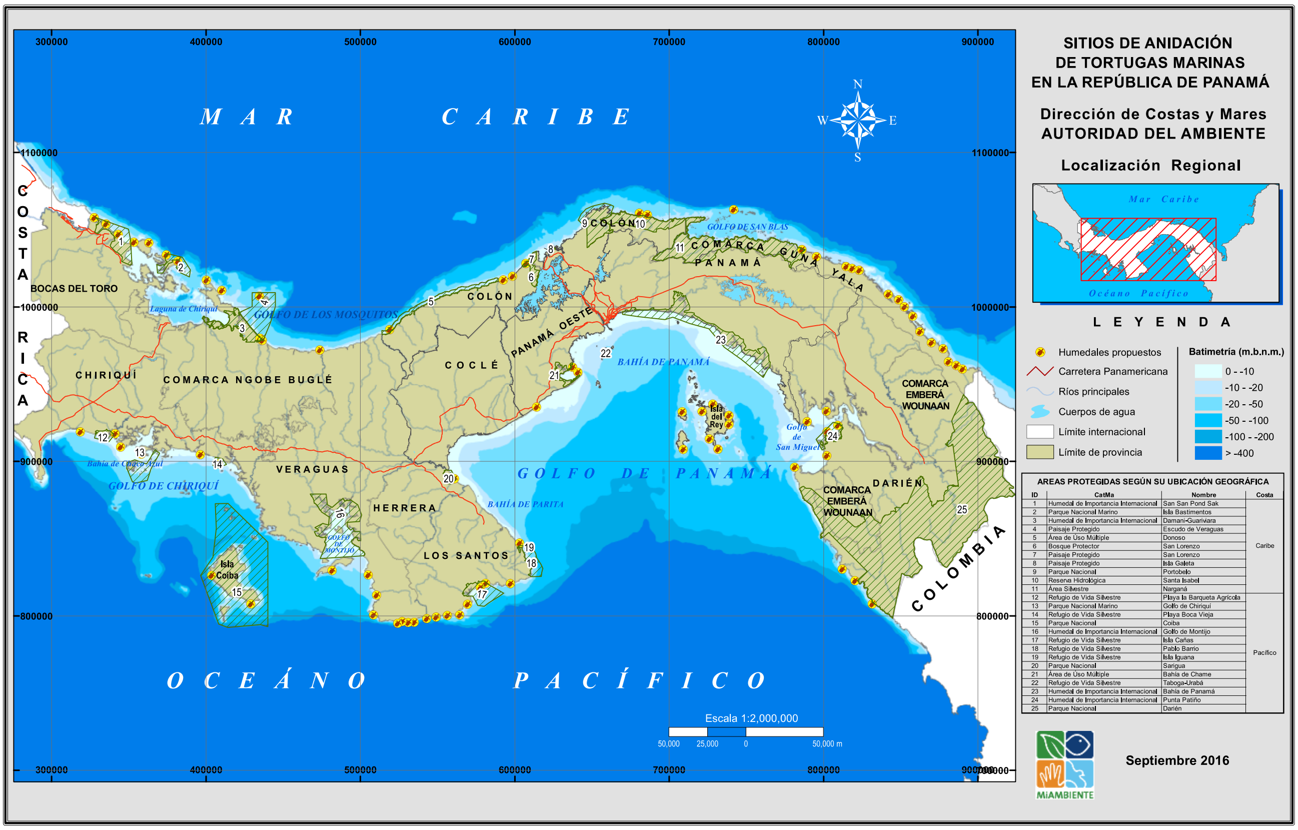

Figure 1a. Sea turtle nesting beaches in the Republic of Panama. Source: *MiAmbiente (2017). Diagnóstico de la Situación de las Tortugas Marinas y Plan de Acción Nacional para su Conservación. E.A. Araúz, L. Pacheco., S. Binder y R. de Ycaza. Panamá, pp 104.*

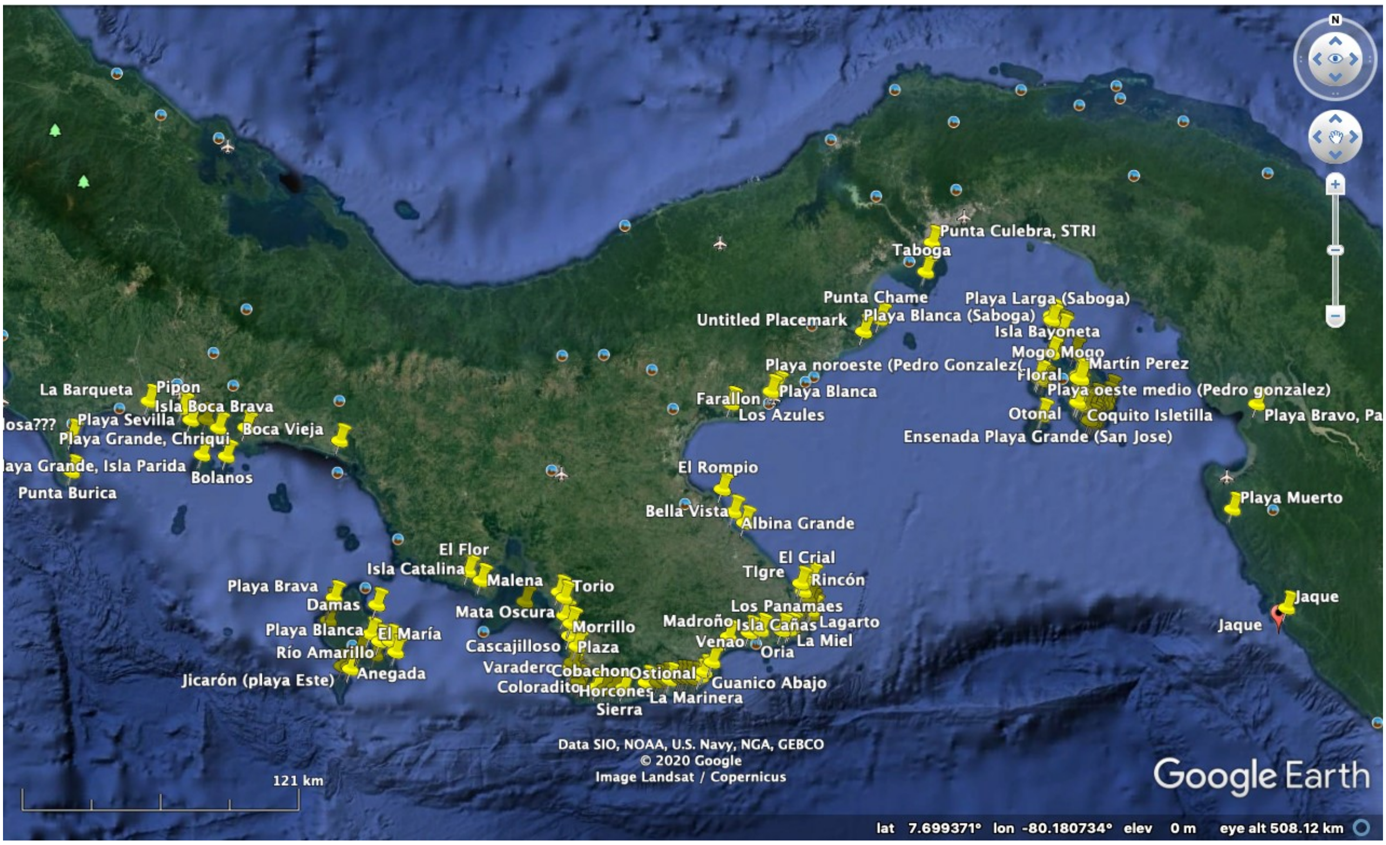

Figure 1b. Sea turtle nesting beaches in the Republic of Panama.

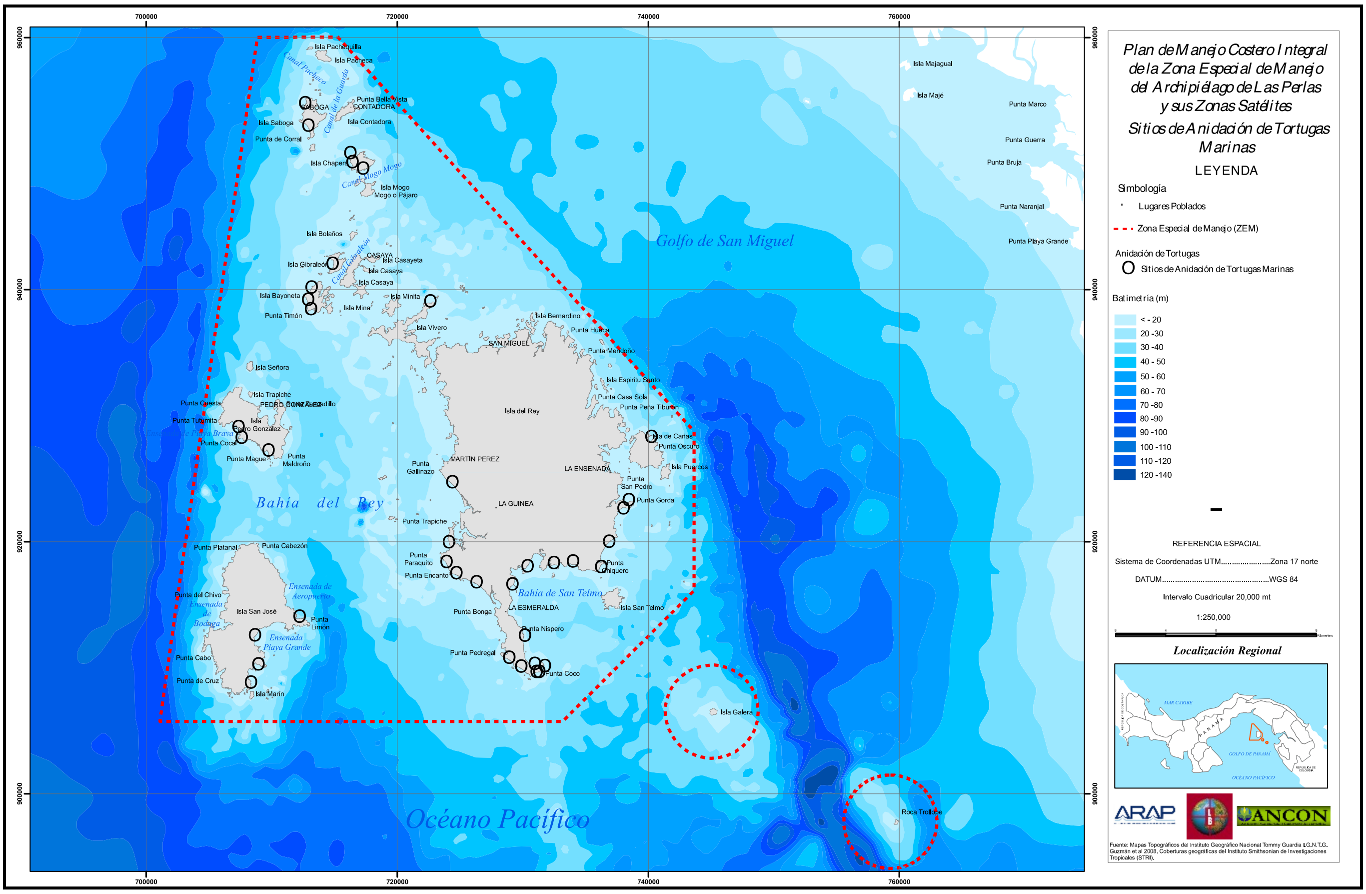

Figure 2. Sea turtle nesting beaches in the Special Management Zone (ZEM) of the Las Perlas Archipelago
Source: *Consorcio Berger-ANCON (2011). Atlas de los recursos marino-costeros de la Zona Especial de Manejo del archipiélago de Las Perlas. ARAP.*

Figure 3. Sea turtle nesting beaches in the Azuero peninsula.

Figure 4. Sea turtle nesting beaches in Coiba National Park**.**

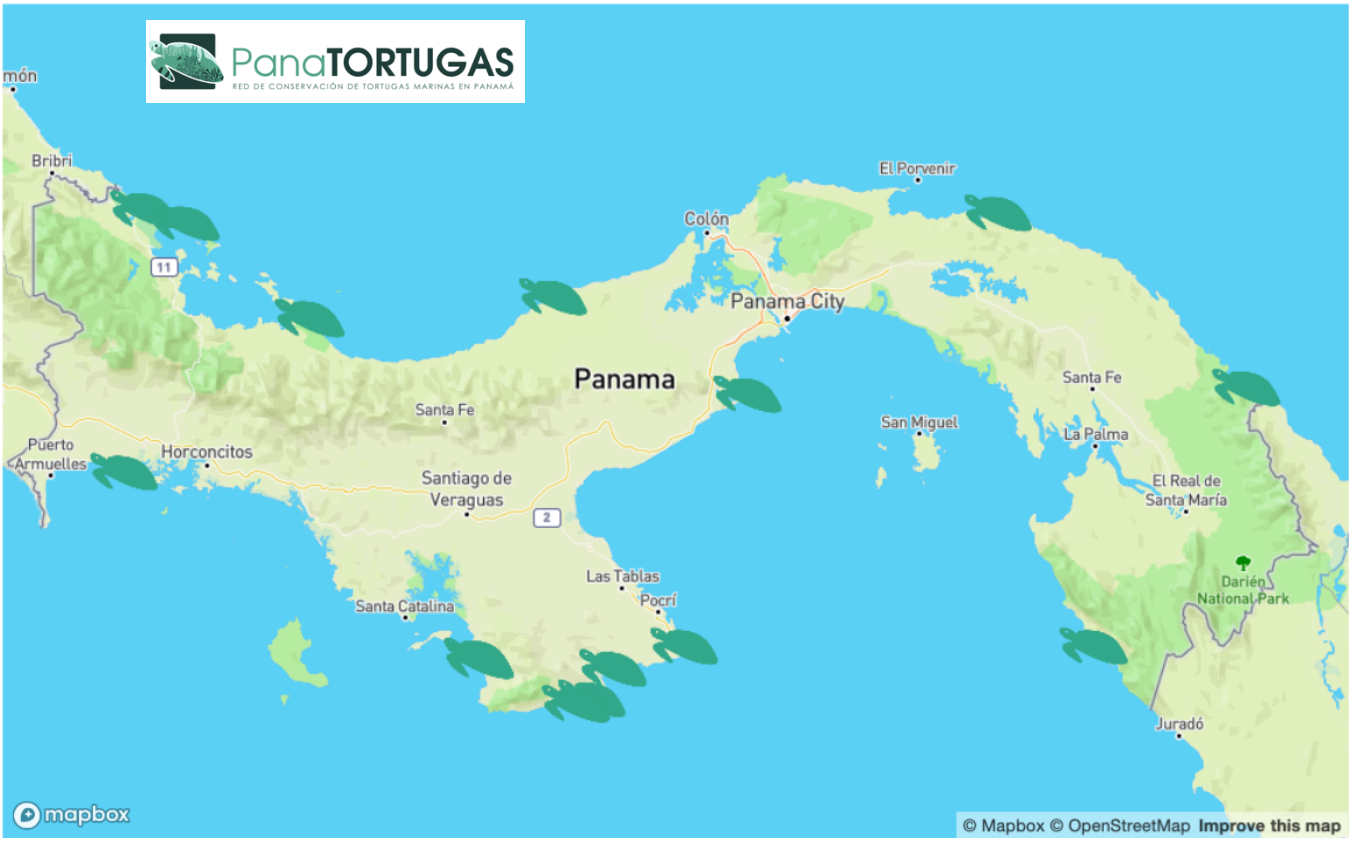

Figure 5. Location of the 14 conservation organizations working on sea turtle conservation in the PanaTORTUGAS network.

Colombia

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1. RMU: Green turtle (*Chelonia mydas*) – Eastern Pacific

1.1. Distribution, abundance, trends

1.1.1. Nesting sites

The nesting density of green turtles is low in the Colombian Pacific. Their nesting season occurs between July and November [33]. The present report only contains quantitative information on scarce nests in El Valle and Palmeras beaches (Table 2); however, there are anecdotic nesting reports in the National Natural Park (NNP) Sanquianga.

1.1.2. Marine areas

The Colombian Pacific is considered an area of importance as a feeding ground and for developing green turtles. However, all the research on feeding ecology and population structure has taken in NNP Gorgona. Studying and protecting other areas is critical since *C. mydas* can remain in its feeding grounds for more than 20 years before migrating to breeding areas [39].

Sea turtles' behaviors at offshore aggregation areas are unexplored in Colombia, through observations from opportunity platforms—on the route between Buenaventura and

Malpelo—Fundación Malpelo y Otros Ecosistemas confirmed the presence of sea turtles. Sightings were taken of four species (*Lepidochelys olivacea, Chelonia mydas*, *Eretmochelys imbricata*, and *Dermochelys coriacea*) [24].

1.2. Research

The Territorial Directorate of National Parks has developed long-term monitoring at La Azufrada and Playa Blanca in NNP Gorgona. This platform has facilitated the development of the highest quality scientific studies in the country. Among research on the area, we find the assessment of trophic ecology through traditional tools and stable isotope analysis [2, 28], experiments on food digestibility items [3], the genetic composition of the foraging population [4], and the intraspecific variation of two morphotypes [27].

2. RMU: Hawksbill turtle (*Eretmochelys imbricata*) – Eastern Pacific

2.1. Distribution, abundance, trends

2.1.1. Nesting sites

Anecdotal information indicates that hawksbill nests irregularly in the Colombian Pacific. The present report does not provide quantitative data on the nesting activities of the species.

2.1.2. Marine areas

NNP Gorgona, NNP Utría, and NNP Sanquianga are recognized as important feeding and development grounds for juveniles of hawksbill. In 2014, an expedition was conducted in NNP Utría, eleven juveniles were captured by hand, and two satellite tags were deployed. Essential data on the size class of juveniles have been obtained from long-term in-water monitoring in NNP Gorgona [21].

Sea turtles' behaviors at offshore aggregation areas are an unexplored subject in Colombia. Through observations from opportunity platforms—on the route between Buenaventura and Malpelo—Fundación Malpelo y Otros Ecosistemas confirmed the presence of sea turtles. Sightings were taken of four species (*Lepidochelys olivacea, Chelonia mydas*, *Eretmochelys imbricata*, and *Dermochelys coriacea*) [24].

2.2. Research

The Territorial Directorate of National Parks has developed long-term monitoring at La Azufrada and Playa Blanca in NNP Gorgona. This platform has facilitated the development of the highest quality scientific studies in the country. Trujillo-Arias and collaborators conducted a phylogeographic study comparing individuals from feeding grounds of NNP Gorgona with turtles from three sites in the Colombian Caribbean [31]. More recently, some ecological and biological features of the species, among the variables tested, the authors assessed some biochemical features on blood samples [29].

3. RMU: Olive ridley turtle (*Lepidochelys olivacea*) – Eastern Pacific

3.1. Distribution, abundance, trends

3.1.1. Nesting sites

Here, we present the most updated available olive ridley nesting data for the Colombian Pacific. This information comes from three departments (Chocó, Cauca, and Nariño). Olive ridley's nesting season in the area takes place from July to December, with nesting peaks in August and September [15, 31].

El Valle is located nearby the NNP Utría and represents the most critical nesting rockery for the species in the South American Pacific [9]. The conservation activities started in 1991 by Fundación Natura included the relocation of nests to in-situ hatcheries. This initiative was determinant for protecting more than 100,000 hatchlings between 1991 and 2001 [22, 38]. Since then, several governmental agencies, NGOs, and universities, such as INVEMAR, CODECHOCO, CIMAD, and WWF, Universidad de Antioquia, and Universidad del Valle, have been participating in interdisciplinary approaches for conserving and researching olive ridleys in the area.

Work by local community members to monitor reproductive activities has been of particular importance. Since 2008, a group of local enthusiastic —Asociación Caguama— has led monitoring and education activities. These efforts have been coordinated with Fundación Natura, the National Natural Parks, WWF, Patrimonio Natural, and CIMAD [Table 2].

The other two critical nesting sites and monitoring programs are located at NNP Gorgona and NNP Sanquianga. The Territorial Directorate of National Parks in the Pacific monitors two beaches, Palmeras (NNP Gorgona) and Mulatos (PNN Sanquianga). In Palmeras, from 2005, the NNP park rangers, along with volunteers, researchers from several NGOs, and Universities, have conducted systematic monitoring and taken relevant information on demographic aspects of females and hatchlings. The average number of nests on this beach is 45.3 per year [6, 13, 16, 17, 18, 19, 25, 26]. In Mulatos, an average of 83.6 nests annually have been recorded from nine years of monitoring [35, 36].

Although we are not showing data from the following beaches, there are reports of them as secondary nesting beaches: San Pichí, Jobí, Nuquí, and Tribugá (Chocó Department); Puerto España, Ladrilleros, Punta Bonita, and Isla Ají (El Valle Department); Naranjo, Guayabal, Amarales, Papayal, Boca Grande, Terán, Milagros, and Boca Nueva (Nariño Department) [38].

3.1.2. Marine areas

There is anecdotal information, mainly by fishers, about the use of neritic and oceanic habitats by *L. olivacea* along the continental and insular waters of the Colombian Pacific. There is no monitoring program to estimate the number of turtles or the size class composition of this species in the area.

Sea turtles' behaviors at offshore aggregation areas are an unexplored subject in Colombia. Through observations from opportunity platforms—on the route between Buenaventura and Malpelo—Fundación Malpelo y Otros Ecosistemas confirmed the presence of sea turtles. Sightings were taken of four species (*Lepidochelys olivacea, Chelonia mydas*, *Eretmochelys imbricata*, and *Dermochelys coriacea*) [24].

3.2. Research

All published research studies on olive ridleys have been conducted in El Valle, Palmeras, and Mulatos beaches. Some demographic and reproductive aspects have been characterized. The importance of the area for the conservation of the species has been estimated [6, 9, 13, 14, 15, 16, 17, 18, 19, 25, 26, 35, 36, PS], the genetic characterization of the nesting colony in Palmeras was conducted in 2008 [10]. A genotoxic biomarker in erythrocytes was assessed at El Valle in 2017 [23].

4. RMU: Leatherback turtle (*Dermochelys coriacea*) – Eastern Pacific

4.1. Distribution, abundance, trends

4.1.1. Nesting sites

Anecdotal information indicates that leatherback nests irregularly in the Colombian Pacific. The present report only provides one quantitative data on nesting activities of the species (Table 2).

4.1.2. Marine areas

There is anecdotal information, mainly by fishers, about the use of neritic and oceanic habitats by *D. coriacea* along the continental and insular waters of the Colombian Pacific. There is no monitoring program to estimate the number of turtles or the size class composition of this species in the area.

Sea turtles' behaviors at offshore aggregation areas are an unexplored subject in Colombia. Through observations from opportunity platforms—on the route between

Buenaventura and Malpelo—Fundación Malpelo y Otros Ecosistemas confirmed the presence of sea turtles. Sightings were taken of four species (*Lepidochelys olivacea, Chelonia mydas*, *Eretmochelys imbricata*, and *Dermochelys coriacea*) [24].

4.2. Research

In 2016, JUSTSEA Foundation started a scalable project in order to generate the information for evaluating the nature and frequency of fishing interactions and their potential effects on sea turtle conservation and to establish collaborative relationships with fishers to promote data sharing and implementation of fishing practices to minimize the impacts of interactions on the survivability of released leatherbacks turtles. Finally, the information generated in this study has been shared with broader, region-wide initiatives (Laúd OPO conservation network, Scientific Committee of IAC, and Bycatch Working Group of IATTC) to characterize bycatch of leatherback turtles in the fisheries of South America and inform management decisions regarding conservation targets under threat reduction scenarios. This research is the first of its kind in Colombia and will lay the groundwork for additional studies and outreach activities.

5. Threats for sea turtles in the Colombian Pacific

5.1. Nesting sites

Long-term and unsustainable harvesting of eggs and adult females, alterations of nesting beaches, and a lack of systematic governance for the sea turtle protection. Other threats include the are erosion of nesting beaches and sand extraction.

5.2. Marine areas

It has been determined through interviews with fishermen that juvenile and adult turtles are consumed when caught incidentally. In general terms, we do not have quantitative information on the effect of sea turtle bycatches in the Colombian Pacific. Through interviews with fishers, we established that juvenile and adult turtles are caught by artisanal and industrial vessels by multiple fishing gear.

6. Conservation of sea turtles in the Colombian Pacific

In the last five decades in Colombia, various efforts have been made to protect, conserve, and research sea turtles. However, there are no rigorous population assessments for any of the species in Colombia. It is thus necessary to implement information management systems on demographic aspects to determine key information for the implementation of effective management measures in nesting beaches and development and foraging areas [37].

Colombia has signed several treaties that ensure the management and protection of sea turtles. Among these is the Convention of International Trade in Endangered Species of Wild Fauna and Flora (Appendix I), the Bonn Convention (Appendices I and II), the Specially Protected Areas and Wildlife (Appendix II), and the Convention on Biological Diversity. Therefore, it is necessary to generate mechanisms to strengthen compliance with the guidelines outlined in instruments and initiatives directed at the recovery and conservation of species, such as the National Program for the Conservation of Marine and Continental Turtles [22] and the National Migratory Species Plan [20], which have objectives such as "collecting and producing information related to the populations of migratory species present in Colombia", "Designing, adopting, implementing and administering a specialized system of public information on species migratory," and "Establishing mechanisms and rules that allow the exchange of information between entities and organizations dedicated to the study and conservation of migratory species at the national level."

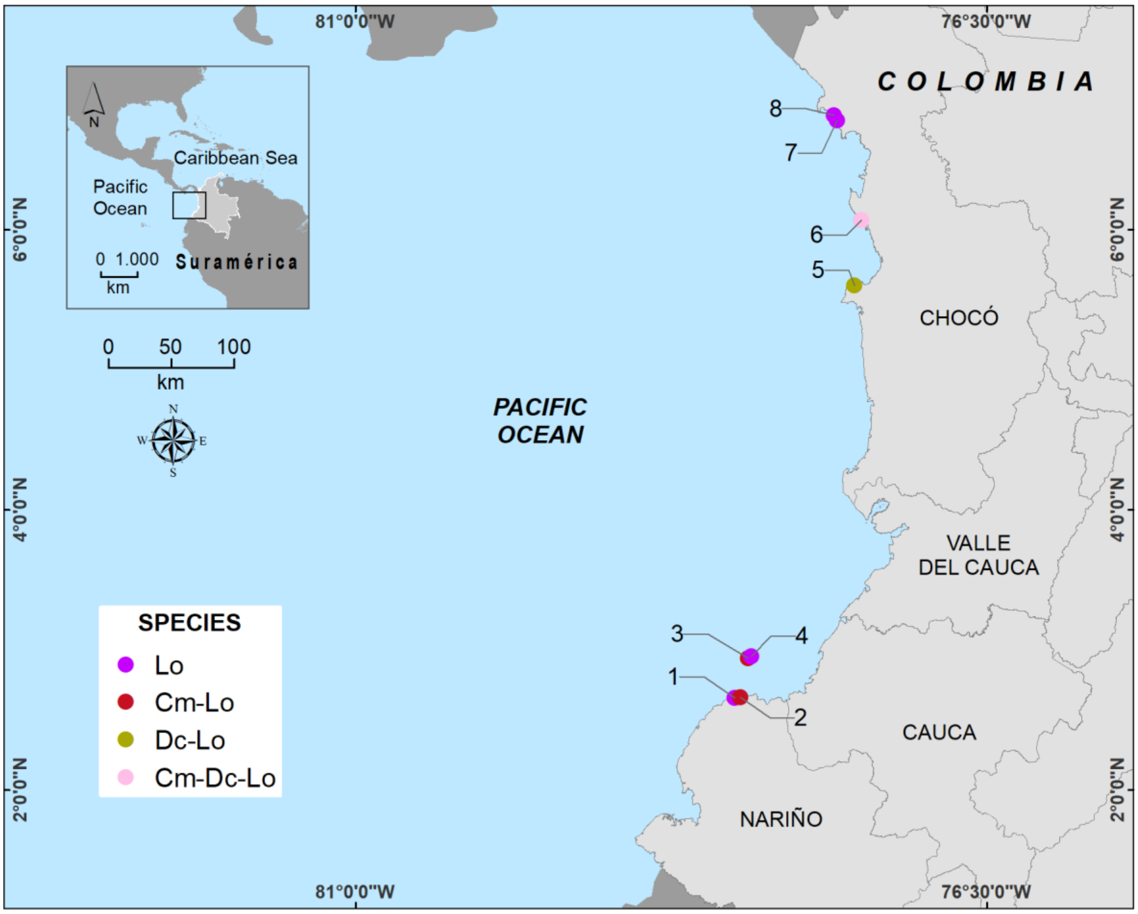

Figure 1. Biogeography and nesting beaches of sea turtles in the Colombian Pacific. 1. and 2. Los Mulatos, NNP Sanquianga, 3. NNP Gorgona, Palmeras, 4. NNP Gorgona, Playa Blanca, 5. Termales, 6. El Valle, 7. Chaguer, 8. Tortuguera.

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Table 1. Biological and conservation information about sea turtle Regional Management Units in Colombia.

RMU								
	L. olivacea EP	**Ref#**	**C. mydas EP**	**Ref#**	**E. imbricata EP**	**Ref#**	**D. coriacea EP**	**Ref#**
Occurrence								
Nesting sites	Y	1,6,7,9,13,14,15,16,17,18,19,25,26,35,36	Y	1,8,19,PS	N	n/a	Y	1
Pelagic foraging grounds	Y	24	Y	24	Y	24	Y	24
Benthic foraging grounds	N	n/a	Y	2	y	19,29	N	n/a
Key biological data								
Nests/yr: recent average (range of years)	Y	Table 2	Y	Table 2	N	n/a	N	n/a
Nests/yr: recent order of magnitude								
Number of "major" sites (>20 nests/yr AND >10 nests/km yr)	3	9,26,35,36PS	N	n/a	N	n/a	N	n/a
Number of "minor" sites (<20 nests/yr OR <10 nests/km yr)	3	1	2	1,8,25,PS	N	n/a	1	1
Nests/yr at "major" sites: recent average (range of years)	Table2	Table2	n/a	n/a	n/a	n/a	n/a	n/a
Nests/yr at "minor" sites: recent average (range of years)	Table2	Table2	Table2	Table2	n/a	n/a	Table2	Table2
Total length of nesting sites (km)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Nesting females / yr	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Nests / female season (N)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Female remigration interval (yrs) (N)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Sex ratio: Hatchlings (F / Tot) (N)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Sex ratio: Immatures (F / Tot) (N)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Sex ratio: Adults (F / Tot) (N)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Min adult size, CCL or SCL (cm)	64LCC	26	n/a	n/a	n/a	n/a	n/a	n/a
Age at maturity (yrs)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Clutch size (n eggs) (N)	92(96)	6,19,35,36PS	n/a	n/a	n/a	n/a	n/a	n/a
Emergence success (hatchlings/egg) (N)	0.8(6028)	25,35,36PS	n/a	n/a	n/a	n/a	n/a	n/a
Nesting success (Nests/ Tot emergence tracks) (N)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Trends								

Recent trends (last 20 yrs) at nesting sites (range of years)	(2001-2017)	8,14,14,19,35,36PS	n/a	n/a	n/a	n/a	n/a	n/a
Recent trends (last 20 yrs) at foraging grounds (range of years)	n/a	n/a	(2003-2017)	25,27	(2003-2017)	25	n/a	n/a
Oldest documented abundance: nests/yr (range of years)	91 (1998)	14	n/a	n/a	n/a	n/a	n/a	n/a
Published studies								
Growth rates	n/a	n/a	Y	27	N	n/a	N	n/a
Genetics	Y	10	Y	4	Y	30	N	n/a
Stocks defined by genetic markers	Y	10	Y	4	Y	30	N	n/a
Remote tracking (satellite or other)	N	n/a	Y	See text	Y	See text	n/a	n/a
Survival rates	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Population dynamics	Y	19	Y	27	n/a	n/a	n/a	n/a
Foraging ecology (diet or isotopes)	n/a	n/a	Y	2,3,28	n/a	n/a	n/a	n/a
Capture-Mark-Recapture	Y	19	Y	27	Y	29	n/a	n/a
Threats								
Bycatch: presence of small scale / artisanal fisheries?	Y	PLL,SN,MT	Y	PLL,SN,MT	Y	SN,MT,FP	Y	PLL,SN
Bycatch: presence of industrial fisheries?	Y	Purse seine	Y	Purse seine	Y	Purse seine	Y	Purse seine
Bycatch: quantified?	Y	See text	Y	See text	Y	See text	Y	See text
Take. Intentional killing or exploitation of turtles	Y	7	Y	7	Y	7	Y	7
Take. Egg poaching	Y	7	Y	7	Y	7	Y	7
Coastal Development. Nesting habitat degradation	Y	7	Y	7	Y	7	Y	7
Coastal Development. Photopollution	Y	7	Y	7	Y	7	Y	7
Coastal Development. Boat strikes	Y	7	Y	7	Y	7	Y	7
Egg predation	Y	7	Y	7	Y	7	Y	7
Pollution (debris, chemical)	Y	7	Y	7	Y	7	Y	7
Pathogens	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Climate change	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Foraging habitat degradation	Y	7	Y	7	Y	7	Y	7
Other								
Long-term projects								
Monitoring at nesting sites	Y	19,PS	Y	19	Y	19	n/a	n/a
Number of index nesting sites	2	6,19,PS	N	n/a	N	n/a	N	n/a

Monitoring at foraging sites								
Conservation								
Protection under national law	Y	20,22	Y	20,22	Y	20,22	Y	20,22
Number of protected nesting sites (habitat preservation)	3	See text	3	See text	3	See text	3	See text
Number of Marine Areas with mitigation of threats	4	See text	4	See text	4	See text	4	See text
Long-term conservation projects (number)	3	19,PS, see taxt	3	19,PS, see taxt	3	19,PS, see taxt	n/a	n/a
In-situ nest protection (eg cages)	Y	19	Y	19	n/a	n/a	n/a	n/a
Hatcheries	Y	35,36	Y	PS	n/a	n/a	n/a	n/a
Head-starting	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
By-catch: fishing gear modifications (eg, TED, circle hooks)	Y	See text	Y	See text	Y	See text	Y	See text
By-catch: onboard best practices	Y	See text	Y	See text	Y	See text	Y	See text
By-catch: spatio-temporal closures/reduction	Y	See text	Y	See text	Y	See text	Y	See text

Table 2. Sea turtle nesting beaches in Colombia.

RMU / Nesting beach name	Index site	Nests/yr: recent average (range of years)	Crawls/yr : recent average (range of years)	Western limit		Eastern limit		Central point		Length (km)	% Monitored	Reference #
LO-EPO												
Chaguera	N	8 (2015)						-77.56603	6.78378	1.5	100	1
Tortuguera	N	8 (2015)						-77.56887	6.79421	1.3	25	1
Palmeras - PNN Gorgona	Y	45.3 (2005-2016)						-78.1153	2.5638	1.2	89	6,13,16,17,18,19,25, 26
El Valle	Y	142.7 (2008, 2017-2018)	202 (2008)					-77.240462	6.042100	8.2	100	9,PS
Los Mulatos - PNN Sanquianga	Y	83.6 (2008-2017)						-78.285831	2.649719	3	100	35,36
Termales	N	20 (2015)						-77.262906	5.362326			1
CM-EPO												
El Valle	N	3.5 (2007-2008)									100	1,8,PS
Palmeras - PNN Gorgona	N	1 (2007,2011, 2016)						-78.1153	2.5638		89	13,19,25
DC-EPO												
Termales	N	2 (2015)						-77.262906	5.362326			1

Table 3. International conventions protecting sea turtles and signed by Colombia.

International Conventions	Signed	Binding	Compliance measured and reported	Species	Conservation actions	Relevance to sea turtles
CBD: Convention on Biological Diversity	Y		Y	ALL	To conserve the biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources, taking into account all rights over those resources and to technologies, and by appropriate funding.	Marine turtle conservation is relevant to the agreement given the species' importance to overall biological diversity. For example, text in Article 8 states that each contracting party shall: "promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings" (CBD, 1992).
CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora.	Y	Y	Y	ALL	An international agreement between governments, the aim of which is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.	All seven species listed in Appendix I of CITES.
Ramsar Convention	Y		Y		It is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.	Based on a MOU between IAC and Ramsar, of the Parties to both Conventions in order to identify and strngthen conservation and wise use of Ramsar Sites (https://www.ramsar.org/sites/default/files/documents/library/mou_seaturtlesconvention_eng_8-7-12.pdf).

Table 4. Projects and databases on sea turtles in Colombia.

Government Agencies
Ministerio de Ambiente y Desarrollo Sostenible
Instituto de Investigaciones Marinas y Costeras , INVEMAR
Parques Nacionales Naturales de Colombia
Corporación Autónoma Regional del Cauca
Corporación Autónoma Regional del Valle del Cauca
CODECHOCO
Autoridad Nacional de Acuicultura y Pesca
Instituto Alexander von Humboldt
Comminity groups
Asociación Caguama
Consejo Comunitario El Cedro
Grupo Interinstitucional y Comunitario de Pesca Artesanal del Pacífico Chocoano, GIC PA
Comunidad Vereda Mulatos
NGOs
JUSTSEA Foundation
World Wildlife Fund Colombia
Conservación Internacional Colombia
Fundación Conservación Ambiente Colombia
Fundación Tortugas del Mar
Fundación Natura
Centro de Investigación para el Manejo Ambiental y el Desarrollo, CIMAD
Fundación Coriacea

Fundación Malpelo y Otros Ecosistemas
Patrimonio Natural
Fundación Zoológico de Cali
Universities
Universidad Jorge Tadeo Lozano
Universidad de Antioquia
Universidad de los Andes
Pontificia Universidad Javeriana
Universidad del Valle
Fundación Universitaria de Popayán

Ecuador

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Ecuador is the southern-most regular nesting country in the Eastern Pacific Ocean for four species of sea turtles: green (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*), hawksbill (*Eretmochelys imbricata*) and leatherback (*Dermochelys coriacea*).

Little was known about Ecuadorian sea turtles, with the exception of the Galapagos Islands, up to about 15 years ago. There were few reports, based on small, short-term projects, coincidental registers, or anecdotal data (23, 22, 7, 40, 3). However, since 2007 several projects have emerged with the objective of studying, monitoring and protecting sea turtles, especially in continental Ecuador (6, 10). Today there are several long-term projects, some carried out by the Ministry of Environment as well as by private initiatives such as NGOs or local communities (27).

Monitoring and nest protection in nesting beaches has had an outstanding increase in effort and in number of sites monitored in the past five years. Many institutions, public and private as well as local communities have started monitoring beaches and protecting nests, and many of the already existing projects have strengthen their efforts and increased their monitoring area. Currently, a total of 58 beaches are monitored regularly along the continental coast; five years ago, the total number of beaches was around 40 (28).

In Esmeraldas province, three official marine protected areas have established long term conservation and monitoring projects that encompass more than 10 beaches; they also visit other beaches upon reports from local communities. Added to this there is one community-based project that seeks to monitor and protect nests from feral dogs. Most nests found in this northern province are olive ridleys', just a few records of green sea turtles, and one hawksbill in 2015 (Equilibrio Azul, unpublished data). In 2021, five leatherback nests were registered in three different beaches from this province; none of them hatched successfully despite enormous efforts to protect and monitor the nests (Sosa, pers.comm.,2021).

Esmeraldas province:

- Refugio de Vida Silvestre Manglares Estuario Rio Esmeraldas: This protected area works at Las Palmas beach since 2016 (8).

- Galera-San Francisco Marine Reserve: they work in more than 10 nesting beaches, in and out of the reserve's boundaries, since 2014 (12, 38).

- Refugio de Vida Silvestre Manglares Estuario del Rio Muisne: they work two nesting beaches and assist to reports in other beaches from the area since 2015, following the work done by Equilibrio Azul in the area since 2011.

- "Reto Same" group: This is a community-based group that monitors Same beach with the objective of projecting nests from feral dogs since 2020 (Sosa, pers.comm., 2021). They work in collaboration with the Galera-San Francisco Marine Reserve.

Manabí province has the largest extension of coast in continental Ecuador, and also the largest abundance of nests and conservation projects in the country, as well as the most longevity in sea turtle research and conservation. All four nesting species nest within this province, with the most important nesting grounds for green sea turtles and hawksbill sea turtles in continental Ecuador. There are a total of three marine protected areas working in sea turtle monitoring and conservation. Added to this, there are four private projects working with sea turtles. In 2021 a total of 7 leatherback nests were registered in 5 different beaches from this province (Equilibrio Azul, unpublished data; Pomilia pers.comm., 2021).

Manabí province:

- Escuela Comunitaria Nueva Esperanza, Puerto Cabuyal: This is a community-based Project that is now working on monitoring and protecting sea turtle nests with the children from the school, since 2020. They also do an important contribution to environmental education (García, pers.comm., 2021).

- Fundación Contamos Contigo Ecuador: They started working in Crucita beach in 2018. Today they cover 10 beaches in the northern part of the province. They work with microplastics issues and environmental education as well (Briones y Pesántez, pers.comm., 2020).

- Isla Fragatas-Corazón: This marine protected area is trained for rescuing and providing first aid to stranded and injured sea turtles before sending them the Machalilla National Park Marine Fauna Rehabilitation Center.

- Refugio de Vida Silvestre Marino Costero Pacoche: This is one of the most successful governmental programs since its beginning in 2012. They work in several beaches within the protected area and attend to nests under reports outside of the area. They also work with environmental education. (34, Solorzano, pers. comm, 2020).

- Machalilla National Park - Centro de Rehabilitación de Fauna Marina: This is the most important rehabilitation center in continental Ecuador. It has been working for several years in rescuing and rehabilitating stranded, injured, and rescued sea turtles from the entire coast. It has proven successful in rehabilitating many sea turtles thanks to the dedicated work of its veterinary staff.

- Fundación Equilibrio Azul: This is the oldest long-term sea turtle research and monitoring organization in continental Ecuador, working since 2007 in several provinces, but especially in Machalilla National Park and its surrounding areas. Their work has been focused on researching and protecting all sea turtle species, with emphasis in hawksbill sea turtles. Currently they are also working to reduce sea turtle, and especially leatherbacks, bycatch mortality. They work with local communities and form alliances with several other organizations. Their work encompasses nesting beaches, aggregation and foraging sites in-water and migratory areas. They use satellite and acoustic telemetry for their research.

- Fundación Jocotoco and Comuna Ancestral de Las Tunas: this organization has done exceptional work with environmental education with Las Tunas community. They are now also monitoring the beach and contributing to protecting nests from feral dogs, as well as collaborating with research organizations. (Delgado, pers.comm., 2020).

Santa Elena province has two important marine reserves that have long-term conservation programs. This province has probably de southern-most nesting grounds for sea turtles in Ecuador that maintain long-term monitoring programs.

Santa Elena province:

- El Pelado Marine Reserve: They work in Playa Rosada, a very important index nesting beach for hawksbill sea turtles in Ecuador (the southern-most for the species) and attend to nests in other beaches in and outside of the Marine Reserve. They collaborate and coordinate the rescue and rehabilitation of sea turtles with the Valdivia Aquarium (Parque Marino Valdivia) (Alvarado, pers.comm., 2020).

- Fundación Ecuador Mundo Ecológico: they work in collaboration with the El Pelado Marine reserve staff to monitor Playa Rosada. They also work with artisanal fisheries in the country's southern ports and have programs seeking to reduce sea turtle bycatch.

- Reserva de Producción Faunística Marino Costera Puntilla de Santa Elena: This is the oldest governmental monitoring program for sea turtles. They patrol beaches within the protected area, attend to reports outside the area and do an important interpretation and environmental education effort.

Guayas and El Oro provinces have little nesting activity, but they are important aggregation sites for green and hawksbill sea turtles in their mangrove estuaries. There is one governmental program that monitors beaches in search of stranded animals; they do basic sea turtle care on injured animals and send them to the Marine Fauna Rehabilitation Center in Machalilla National Park.

- Área de Recreación Playas Villamil: They patrol the beach looking for stranded animals. They attend to stranded animals and coordinate with Machalilla National Park's rehabilitation center for further care (Quinde, pers.comm., 2020).

The Galapagos Islands have had extensive research on its sea turtles. The Galapagos National Park is now in charge of monitoring beaches that were initially monitored and researched by the Charles Darwin Foundation (CDF). Researchers from the Galapagos Science Center from Universidad San Francisco de Quito have research programs with green and hawksbill sea turtles in a project called "Tortuga Negra".

Galápagos:

- Galápagos National Park: The Park is in charge of monitoring the main nesting beaches for green sea turtles since 2015. They work in collaboration with the Ecology Project International (EPI) and the Galapagos Conservation Trust.

- Proyecto Tortuga Negra – Galapagos Science Center, Universidad San Francisco de Quito: This Project works with sea turtles in-water doing research in ecology and interactions with microplastics. They work in the entire archipelago thru expeditions collecting data for green and hawksbill sea turtles.

- Fundación Charles Darwin: CDF started nesting sea turtles research in the main nesting beaches from Isabella and Santa Cruz islands many years ago, program that is now led by the National Park.

Since 2014, Ecuador has a Sea Turtle National Plan (Plan Nacional de Tortugas Marinas) (26) that has now been updated with an action plan that will function up to 2030 (25). It supports all established monitoring programs along the coast, especially within protected areas. The country also collaborates with international agreements such as the IAC, IATTC, Lima Convention, CMS, and CITES.

In continental Ecuador, all species are threatened with habitat destruction as the coasts' development has accelerated at alarming rates during the past 10 years with little or no control. Constructions over nesting grounds and beach sand use are deteriorating the nesting grounds in all provinces (27). In Guayas and El Oro there is also an alarming threat of mangrove destruction as the aquaculture, agriculture and urban limits continue to expand, entering mangrove and estuarine areas, despite the protection that mangroves have in the country. Bycatch remains the main threat for all species, augmented by a lack of control and enforcement in no-take zones such as National Parks, where important aggregations sites for hawksbill and green sea turtles have been identified (Equilibrio Azul, unpublised data). Feral dogs in the entire coast are and increasing problem for all species (27).

In the Galápagos islands, threats are not related to habitat destruction but rather related to illegal fishing, bycatch, microplastics, pollution and climate change (Alarcón, pers.comm. 2021); threats that are also present in continental waters.

1. RMU: Loggerhead turtle (*Caretta caretta*) – Pacific East

1.1. Distribution, abundance, trends

1.1.1. Nesting sites

No nesting has been registered for this specie in Ecuador.

1.1.2. Marine areas

The only existing records of this species presence in Ecuadorian waters are from 383 sightings in pelagic waters from observers from the Inter American Tropical Tuna Commision (IATTC) between 1993-2002, and from one stranding event reported in 2017 (4, 39).

1. 2. Other biological data

There are no other records for this species in Ecuador.

1.3. Threats

There are no records of this species in nesting grounds for Ecuador.

1.3.2. Marine areas

By-catch and interactions with fishing gear (floating objects and possibly ghost nests) are the main threat for this species in marine areas, given the reports from industrial fishery interactions and by-catch (4).

2. RMU: Green turtle (*Chelonia mydas*) – Pacific East

2.1. Distribution, abundance, trends

2.1.1. Nesting sites

The most important nesting grounds for this species are in the Galápagos Islands, where the main beaches that are monitored have more than 2,000 nests for Quinta Playa in Isabela, more than 1,000 for Bahía Barahona and more than 600 for Las Bachas in Santa Cruz, according to data between 2009-2015 (12, 13; 32). More recent data from the 2020-2021 nesting season only report 425 nests for Quinta Playa and 100 nests for Las Bachas (24); however, it is possible that there has been a decrease in monitoring effort.

In continental Ecuador, nesting for this species has been registered in a total of 22 beaches along the coast with the highest frequency and abundance in south-central Ecuador, in Manabí province and specifically in Machalilla National Park (Fig. 1).

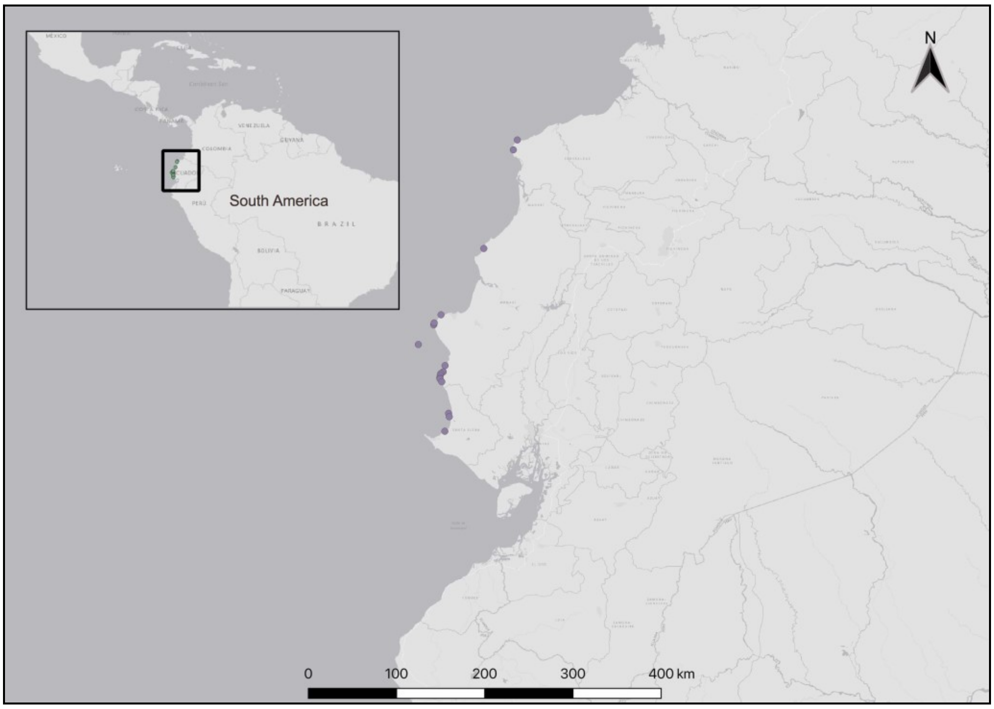

Figure 1. Nesting distribution for green sea turtles (*Chelonia mydas*) along the Ecuadorian coast. Each dot represents a beach where there has at least been one nest for this species. (Map by Cristina Miranda).

The most important nesting beach for green sea turtles in continental Ecuador is Bahía Drake in Isla de La Plata (Machalilla National Park) where up to 48 nests have been registered per year (33, 15), representing more than 50% of the total nests registered in the coast each year; the rest of the beaches add on average a total of 28 nests per year (Fig. 2). Between 2008-2013, 81 nesting females were identified at Bahía Drake (44,50) The highest concentration of nests for green sea turtles are found in Manabí in Machalilla National Park's area (Fig. 3).

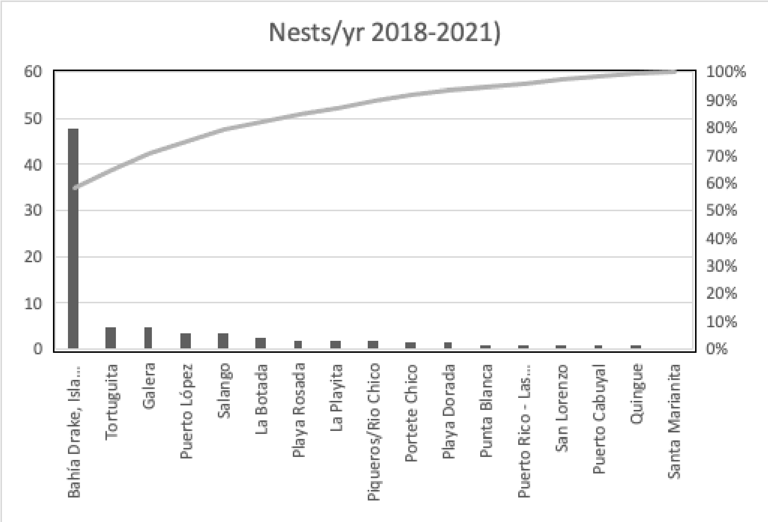

Figure 2. Number of average nests per year for green sea turtle nests registered per beach between 2018-2020. Only the nests for Bahía Drake belong to a different year, as there Is no data available for this beach for the 2018-2021 period.

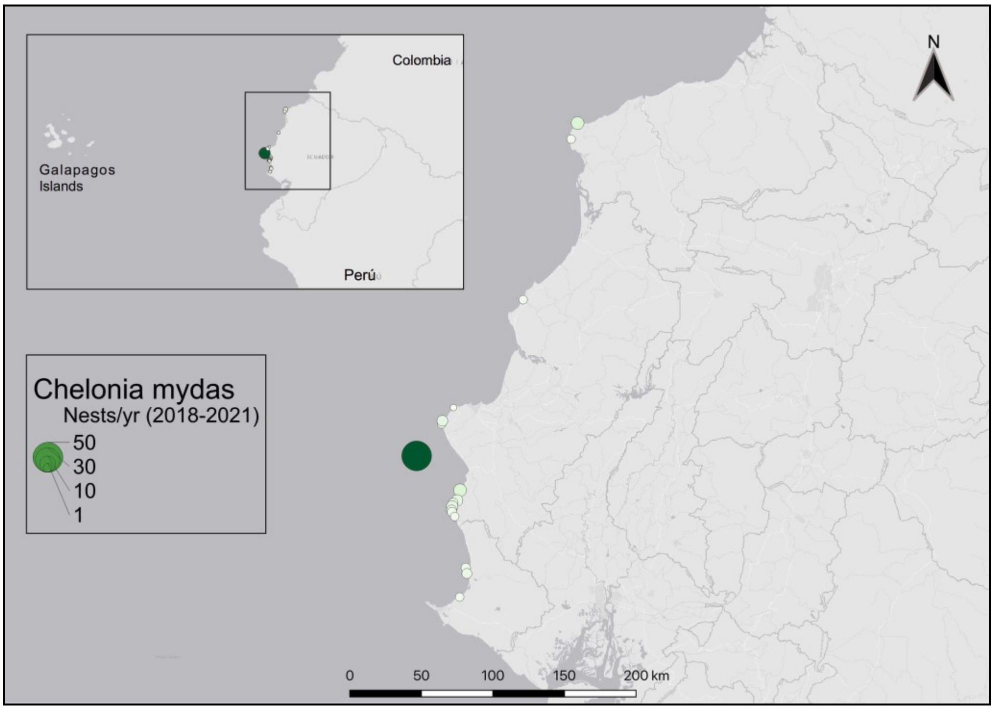

Figure 3. Green sea turtle nest distribution and abundance for the 2018-2021 period (excluding Bahia Drake). (Map by Cristina Miranda).

2.1.2. Marine areas

Green sea turtles, both black, green and yellow morphs, are found in rookeries, reefs and aggregation sites of continental Ecuador and the Galapagos Islands.

Machalilla National Park in continental Ecuador, is not only the most important nesting area for this species in the continent, but also the most important aggregation site in-water. Between 2008-2013, a total of 403 individuals were identified through capture-recapture efforts at Isla de La Plata, Machalilla National Park (44,50). This species is also found associated to human activities; for example, in Puerto López town within Machalilla National Park's influence area, there is an aggregation of this species at the fish market where they feed on fish scraps that are discarded from the fishery (Equilibrio Azul, unpublished data).

The Galapagos Islands are one of the most abundant sites for green sea turtles in the Eastern Pacific Ocean. It has a mix stock of populations and a predominant black morphotype (9). The most important studied foraging grounds are Punta Espinoza, Bahía Elizabeth, Caleta Derek and Punta Nuñez, where between 2000-2008 a total of 1065 individuals were captured and tagged (41). Since 2015 recent studies have found broader aggregation and foraging areas at the archipelago where abundant numbers of individuals are described at coastal areas of San Cristobal, Española, Floreana and Isabela islands (Alarcón pers.comm., 2021) (Fig. 4). Using tagging and photo identification methods 800 individuals of green turtles have been registered with a recapture rate of 33% (2, León, et al. unpublish data).

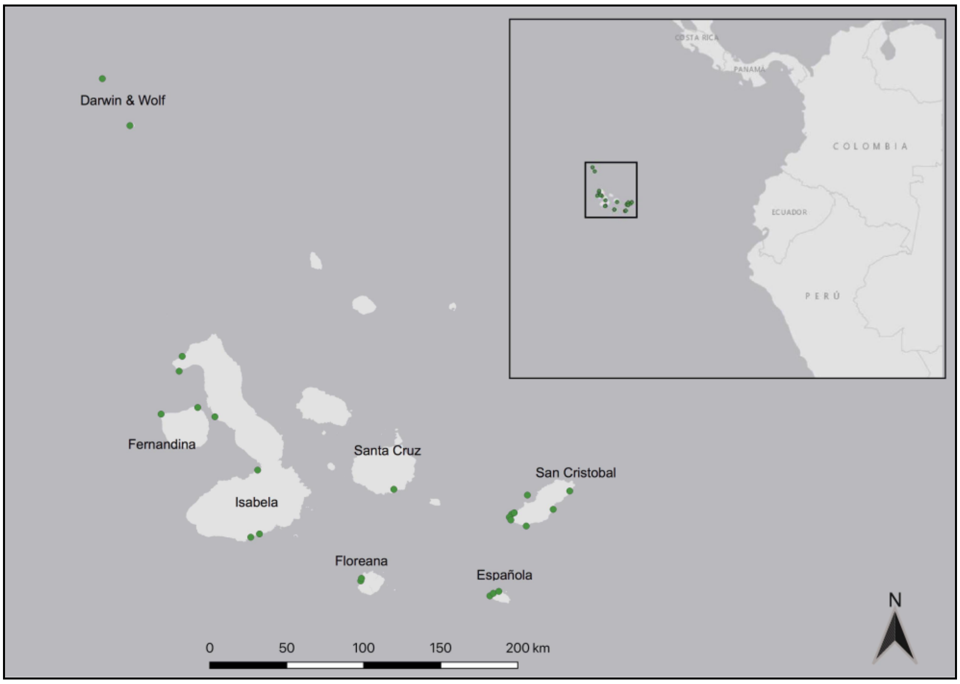

Figure 4. Sites where aggregation sites have been identified in the Galapagos Islands for green sea turtles (*Chelonia mydas*) (Alarcón-Ruales & Muñoz-Perez, unpublished data). (Map by Cristina Miranda).

In terms of migration, four types of migratory patterns have been described for nesting green sea turtles from Galapagos: 1. Residents. 2. Migrating to Central America. 3. Migrating to the continent in South America. 4. Southwest oceanic migrations (36). Furthermore, connectivity between the Galápagos Islands and continental Ecuador has been identified by genetic analysis of green sea turtles in Machalilla National Park and the Galapagos, showing no genetic differences between the two sites (9) and also through capture-recapture programs where one individual tagged at Isla de La Plata (continent) was observed nesting at Quinta Playa-Isabela, Galapagos (44,50).

2.3. Threats

2.3.1. Nesting sites

The main index nesting sites for green sea turtles are located inside protected areas and National Parks where there are little direct human related threats such as habitat destruction or artificial lights. Bahía Drake is the most important nesting site in continental Ecuador; it is a protected beach at Isla de la Plata, Machalilla National Park. However, nests are threatened with sea level rise, as it is a very narrow beach.

In other beaches, where even though the nesting activity for this species is less abundant, threats are habitat destruction due to coastal development and sand removal, artificial illumination, depredation by feral and domestic dogs, and to a minimal extent egg and turtle poaching, which is illegal.

In the Galápagos Islands threats to nests by human activities are minimal, most of the beaches are away from human settlements and are of very difficult access. Tortuga Bay in Santa Cruz Island has the highest threats to its nests as it is a highly touristic beach where thousands of visitors go every year, and where public events take place. A reported threat to nests in Galapagos comes from native and introduced species such as flies, beetles, ghost crabs and feral pigs; inundation is also a cause of nest failure (42, 63).

2.3.2. Marine areas

The greatest threat for this species is by-catch as this species interacts with fisheries with high frequency. A big percentage of green sea turtles at Isla de La Plata are observed with hooks and other injuries produced by fishing gear (Equilibrio Azul, unpublished data, Alemán, pers.comm.). The Machalilla National Park Marine Fauna Rehabilitation Center (Centro de Rehabilitación de Fauna Marina del Parque Nacional Machalilla) constantly treats sea turtles with injuries from boat strikes, propeller lesions and fishing gear (animals are brought from all around the continental coast).

Between 1994-1995 a total of 76 green sea turtles were found stranded due to interactions with fisheries, and between 2014-2017 a total 255 were registered by the Ministry of Environment (39).

Boat strikes are a common threat on both continental Ecuador and the Galápagos islands (2). In 2014, the Charles Darwin Foundation reported injuries in 12% of the 1458 nesting females evaluated in Quinta Playa (32).

In the continent an increasing amount of tourism operators feed green sea turtles to attract them to the boats; at Isla de La Plata, within Machalilla National Park, this is a common practice.

Plastic pollution and ghost nests are an increasing problem and threat to the survival of green sea turtles. It has been found that not only do they ingest macro-plastics, but they also have microplastics in their digestive system (Múñoz-Perez, unpublished data).

2.4. Conservation

All sea turtle species are protected under Ecuadorian law, making it illegal to kill, or manipulate sea turtles or their derivates (shells and eggs). The government as well as the IACCT have promoted the use of Turtle Exclusion Devices (TEDs) and circle hooks, it is not obligatory or enforced.

In continental Ecuador there are plenty of initiatives (public and private), as exposed in the introduction, that are working in protecting nests of all sea turtle species and that are working with environmental education.

2.5. Research

Equilibrio Azul has research programs with this species both in nesting beaches and in-water. The Galapagos Science Center (GSC) from San Francisco de Quito University works with the "Tortuga Negra" project that focuses on green sea turtle in-water research working with the black and yellow morphs, mainly in San Cristobal Island. Charles Darwin Foundation also has developed several research projects with this species.

3. RMU: Hawksbill turtle (Eretmochelys imbricata) – Pacific East

3.1. Distribution, abundance, trends

3.1.1. Nesting sites

Ecuadorian hawksbill sea turtles, as well as in the entire EPO region, were thought to be extinct up until 2007-2008. In 2007, La Playita in Machalilla National Park was found not only to host hawksbill nesting females, but to have important numbers of nests making it an index nesting beach for this species (17, 19).

Since then, more nesting beaches have been registered for this species including another index nesting beach called Playa Rosada in El Pelado Marine Reserve, about 50 km south from La Playita (19).

Between 2018-2021, more than 100 nests per year, on average, were registered in a total of 14 beaches between southern Manabí and Santa Elena provinces. More than 60% of the nests were distributed in the two main index beaches (La Playita and Playa Rosada), being La Playita, in Machalilla National Park the most important one for this period (Fig. 5) (24, Equilibrio Azul, unpublished data, Alvarado, unpublished data). Machalilla National Park and its surrounding area represents the most important nesting area for this species to date with the great majority of nests (73 out of 103 on average per year, between 2018-2021) found in a total of 11 beaches, seven of which are within Machalilla National Park (Equilibrio Azul, unpublished data) (Fig. 6).

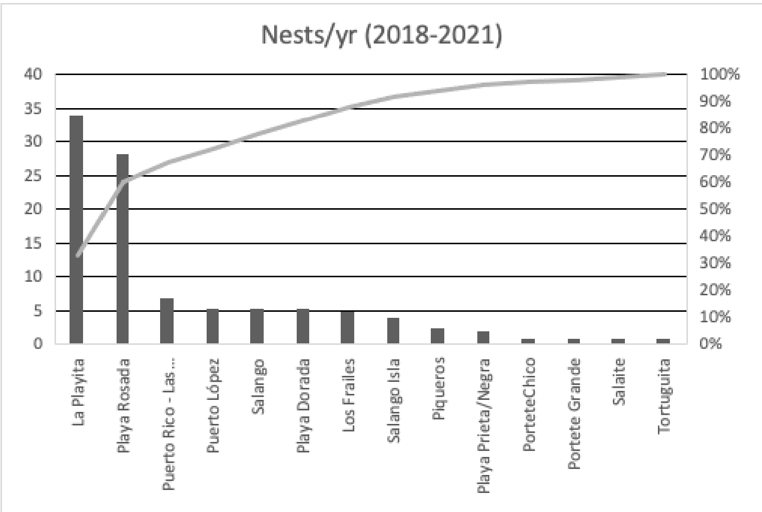

Figure 5. Average number of nests per year, per beach for hawksbill (*Eretmochelys imbricata)* sea turtles in Ecuador between 2018-2021.

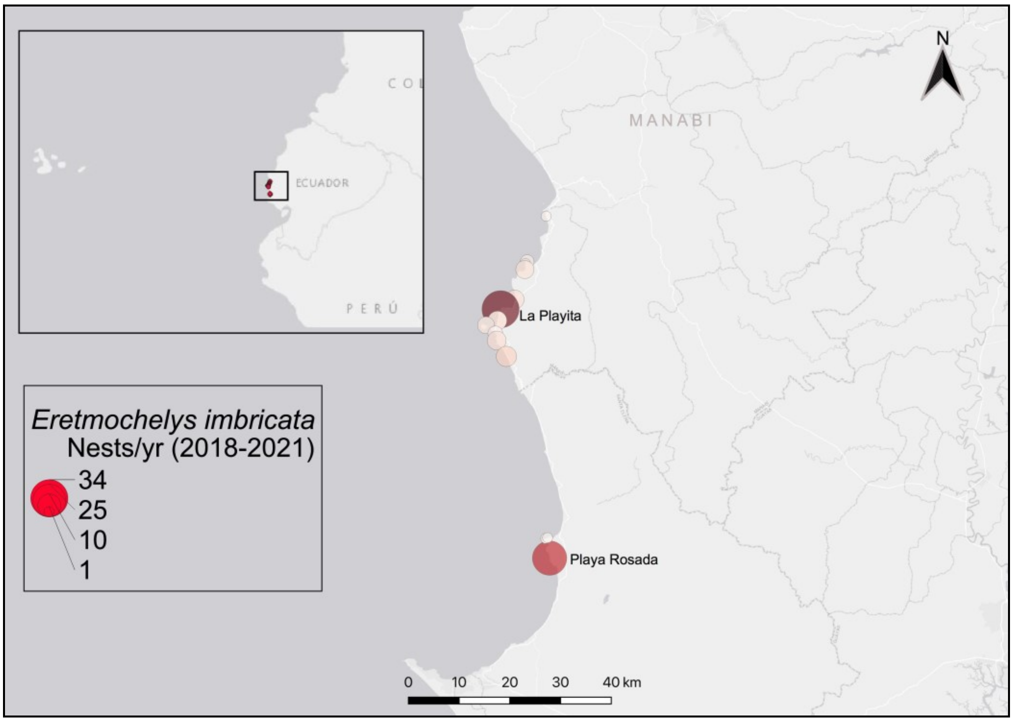

Figure 6. Nest distribution and abundance for hawksbill (*Eretmochelys imbricata*) sea turtles in south central Ecuador. Larger and darker circles represent the beaches with greater abundance. (Map by Cristina Miranda).

More than 50 nesting females have been identified and tagged at La Playita (Equilibrio Azul, unpublished data; 19.), and at least 10 nesting females at Playa Rosada (19). According to Gaos et al., (2017a.), tagging efforts of females in Machalilla National Park are close to their saturation point.

The 2019-2020 nesting season for hawksbills at Machalilla National Park was the best nesting season recorded since Equilibrio Azul started monitoring La Playita beach and other 12 beaches of the area, with more than 60 nests registered for the 2019-2020 period (Equilibrio Azul, unpublished data).

3.1.2. Marine areas

A long-term research study taking place by Equilibrio Azul has identified Machalilla National Park's rocky and coral reefs as the most important foraging grounds for juveniles and adults of this species. Within this study, from 2008 to 2016 a total of 143 hawksbill captures were done in a small area of fragmented reefs of Machalilla National Park, identifying around 60 hawksbill individuals. Of those captures, 71% were juveniles, 15% adult females and 13% adult males (Miranda, 2016, unpublished report). Other foraging grounds are hypothesized based on by-catch, in-water census, and personal communications with local people and fisherman in rocky and coral reefs in El Pelado Marine Reserve, Reserva de Producción de Fauna Marina Costera Puntilla de Santa Elena, Isla Puná, Archipiélago de Jambeli, and the mangrove estuary of San Lorenzo in Esmeraldas Province. By-catch reports suggest that the Galera-San Francisco Marine Reserve could also be an aggregation site and foraging ground.

Through satellite telemetry on nesting females, a migratory route has been identified after breeding seasons from Machalilla National Park: nesting females migrate south of Ecuador after nesting and stay in mangrove estuaries and islands for the rest of the year/s (18, 66), on average they remigrate to their nesting ground in Machalilla National Park after 1.9 years (19). The only female tagged so far at Playa Rosada showed the same behavior (Darquea et al., 2016, unpublished report). Some of the females tagged also visited and temporarily stayed at other reefs and rookeries such as Anconcito, south of Machalilla National Park, in Santa Elena province (Equilibrio Azul, unpublished data).

Neonate hatchlings have also been acoustically tracked by Equilibrio Azul, showing to migrate to pelagic waters, and 6 one-year old neonates have been tracked with satellite tags to study the "lost years" phase, all of them with the exception of one, were born in Machalilla National Park (Miranda et al., unpublished data).

This species has predominantly coastal behavior in continental Ecuador, especially for the post-natal foraging phase, which according to genetic analysis done by Gaos et al., (2017b.) have a strong philopatry to their natal grounds during this life stage. Similar behavior has been observed in the Galapagos Islands; satellite telemetry of three juvenile hawksbills in San Cristobal Island has shown no specific migratory patterns with turtles staying within the Islands' reefs, close to shore, displaying high philopatry for their foraging sites (1; Alarcón-Ruales & Muñoz-Perez, unpublished data).

Through capture-recapture, connectivity between the Galápagos Islands and continental Ecuador has also been confirmed; Equilibrio Azul captured a male hawksbill in 2016 in Machalilla National Park that had originally been tagged 13 years before as a juvenile in the Galapagos Islands by Patricia Zárate (Miranda et al., unpublished data).

In the Galapagos Islands hawksbill turtles are reported throughout the entire archipelago; thanks to capturing efforts and photo identification, 20 different sites have been identified (Fig. 7) with multiple reports and 38 individuals identified, mostly juveniles and only one adult male (Alarcón-Ruales & Muñoz-Perez, unpublished data). Genetic analysis on hawksbill juveniles from the Galapagos suggests that the Galapagos may be receiving individuals from the Indo-Pacific as well as from the Eastern Pacific (21).

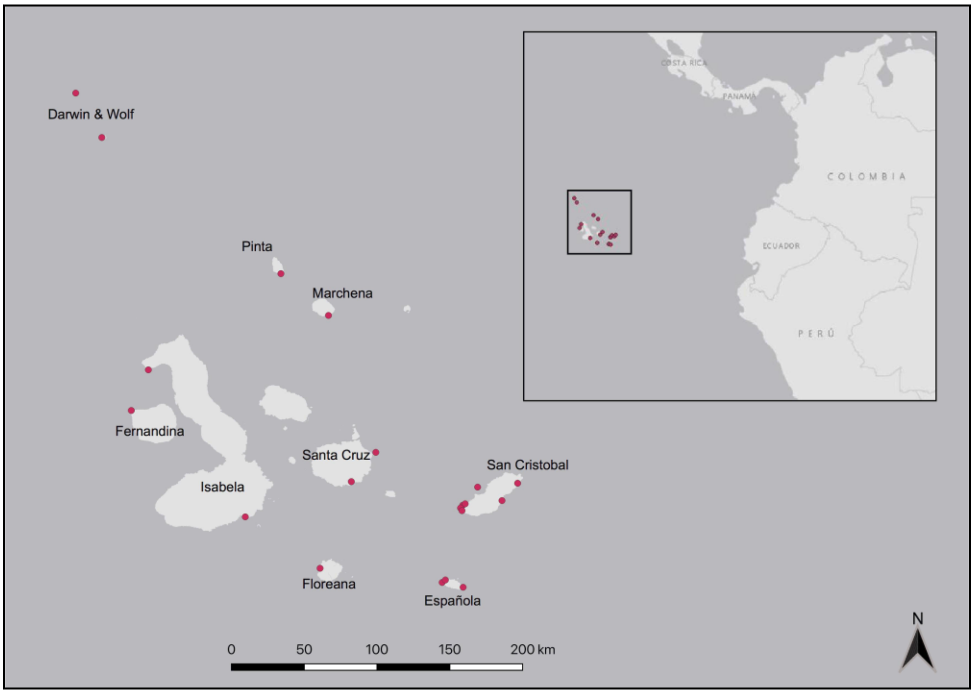

Figure 7. Hawksbill (Eretmochelys imbricata) sea turtle sites at the Galapagos Islands. (Alarcón-Ruales & Muñoz-Perez, unpublished data) (Map by Cristina Miranda).

3.2. Other biological data

During the 2018-2019 hawksbill nesting season, Equilibrio Azul registered a hybrid nest between hawksbill and green sea turtles (Equilibrio Azul, unpublished data).

3.3. Threats

3.3.1. Nesting sites

Nesting sites for hawksbill sea turtles are threatened mainly due to habitat destruction for development, artificial illumination and sand extraction. Despite that the two main index beaches are inside protected areas, one of which – La Playita – has special protection, they are not without threats. Playa Rosada in El Pelado Marine Reserve has been altered with the construction of tourism facilities on the beach and its surroundings. Development has increased artificial illumination and there is as access for invasive and destructive species such as feral and domestic dogs. Vegetation on beaches is often destroyed (burned or cut down) to present a "clean" landscape for tourists.

La Playita in Machalilla National Park is a protected beach with restricted access to the public; the conservation of hawksbill sea turtles was the purpose of restricting access to this beach since 2008; however, in 2016 a trail was built with the purpose of providing tourism opportunities to the community of Salango with the condition that no tourist could enter the beach, access was granted only to the viewpoint, and not without a guide, however there is little or no control. The creation of this trail has increased the number of people entering the beach during the day or illegally camping on it (increasing cases of bonfires, dogs, and pollution). The National Park has no resources to constantly monitor the entrance to the trail and therefore to the beach.

Added to this, in June 2021, a group of people started claiming that La Playita and its surrounding forest (a total of 140 hectares) is private land (Fig 8), for which they claim to possess the legal documents that prove it; to this claims the local Municipality of Puerto López accepted the documents and registered them. This is an extreme threat as these people have the intention of selling lots in the area and urbanizing the most important nesting area for hawksbill sea turtles in the country (and probably in the South American Pacific Ocean), that up to this moment remains in good conservation conditions. The Ministry of Environment assures that it is illegal, and that no disturbance will be allowed in the area as it belongs to Machalilla National Park since the 1970s and has the highest level of protection (Ecuador Terra Incógnita, July-August 2021).

Figure 8. A sign depicting "Private Property"placed over Machalilla National Park's entrance sign at La Playita's by people claiming to own the beach and its surrounding forest, 2021.

Nesting beaches outside protected areas, especially the ones that have cities or towns next to them, are threatened with destruction by development projects, sand extraction, vehicle entrance (Fig 10), artificial illumination, depredation by feral and domestic dogs (Fig. 9), and illegal egg harvesting (27). In the past 15 years a construction boom has taken place in the coast of Ecuador accelerating the destruction of nesting habitat.

Figure 9. Nesting hawksbill sea turtle that was attacked by domestic dogs at Puerto Cabuyal while she was attempting to nest in 2020. The turtle was rescued by members of the local community with severe injuries on both frontal flippers and neck. Photo: Alexandra García.

a.

b.

Figure 10. Examples of nesting habitat destruction in Ecuador in hawksbill nesting beaches. a.) beaches are used as parking lots or as vehicle roads, and b.) constructions on beaches on nesting areas. Photos by Felipe Vallejo and Sofia Jones, Equilibrio Azul.

Stranding and by-catch for this species are not very common, which could be related to their scarce abundance; however, in 2021, at least five stranding events of juveniles hawksbills showing signs of drowning were registered by Equilibrio Azul in Machalilla National Park and its influence area.

3.3.2. Marine areas

Habitat destruction with development is also a threat to important hawksbill habitat such as mangroves and reefs. Rafael Correa's government constructed several large-scale artisanal fishing ports, some of them on known hawksbill reefs and within protected areas such as Machalilla National Park. Despite the fact that law protects coral reefs in Ecuador and of the special protection through IAC for hawksbill foraging habitat, these constructions have taken place destroying entire reefs.

Another important threat is habitat destruction from anchors (artisanal fishing boats and tourism boats).

Overexploitation of reefs (even inside the protected areas) by artisanal fisherman depleting reefs of life.

Drift and gillnets within foraging and aggregation areas, and especially inside protected areas, as well as in migratory routes. Lobster nets have been observed in hawksbill reefs inside Machalilla National Park and its surrounding areas.

Plastics, ghost nets, and fishing gear are an increasing problem. Health assessment of a few hawksbill individuals in the Galapagos show a baseline of a healthy population, however plastic pollution and fishing pressure has been reported to be a threat for this species (Muñoz-Perez unpublished data).

By-catch and direct catch are a threat to this species as well. The existence of a black market of hawksbill shell for artisanal jewelry and in (probably) a bigger scale for cock fighting spurs is of concern (Fig. 11).

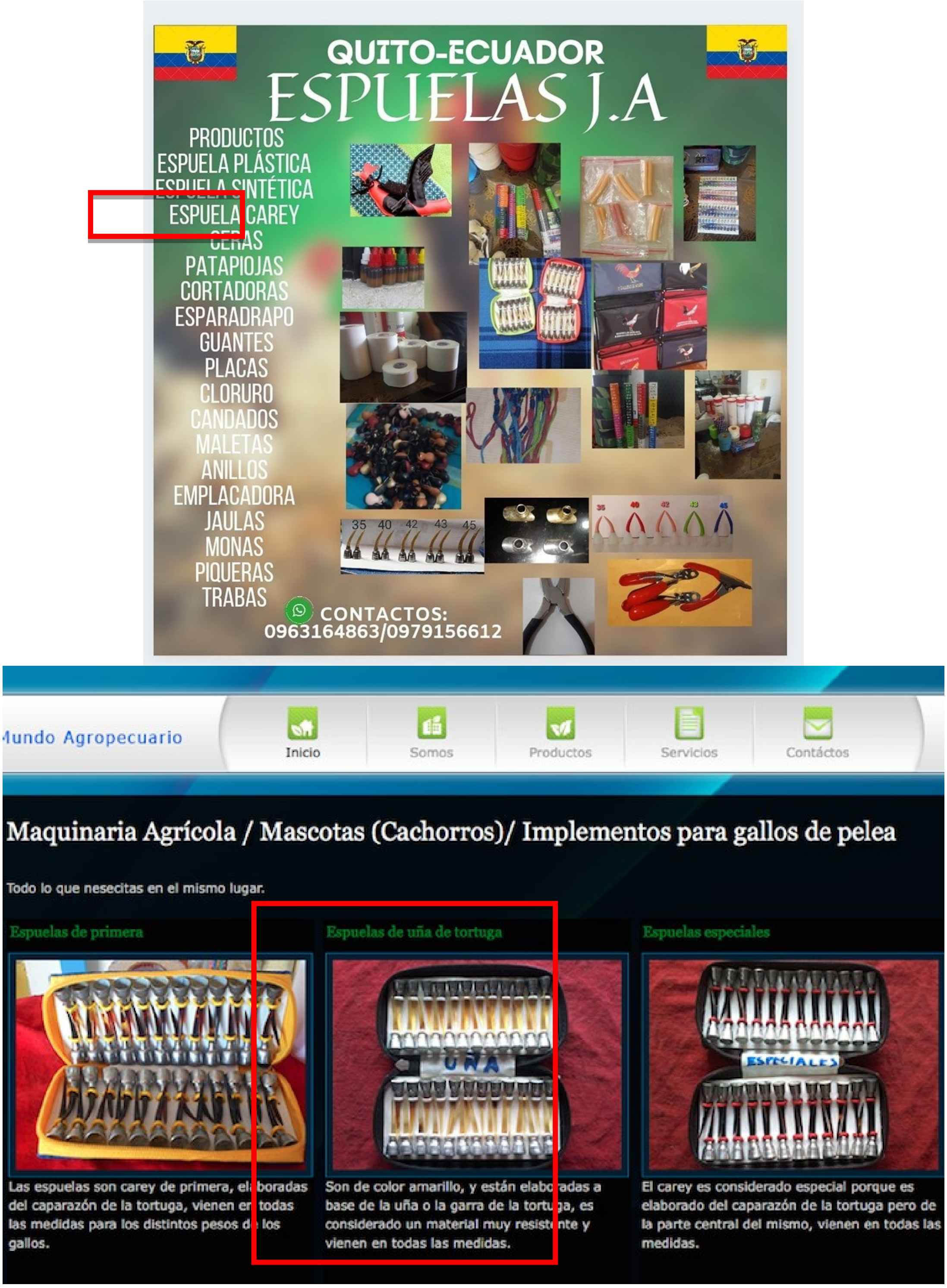

Figure 11. Examples of sales offered in social media in Ecuador of cock-fighting spurs made out of hawksbill sea turtle shells.

3.4. Conservation

Ecuador has offered to protect hawksbill sea turtles under several international and regional agreements such as the IAC's hawksbill resolution, to which Ecuador is a signatory. The same happens with CITES and furthermore, Ecuador aims to protect hawksbills under the Plan Nacional de Tortugas Marinas. Ecuador's legislation protects coral reefs and mangroves which are important hawksbill habitat.

Their most important nesting grounds are in protected areas: Machalilla National Park (the most important protected area and the only National Park in the coast) and El Pelado Marine Reserve.

There is one large marine reserve (Machalilla-Cantagallo Marine Reserve) that connect both nesting grounds with their foraging areas.

There are 3 long-term projects taking place with this species: El Pelado Marine Reserve, working with nests at Playa Rosada. Equilibrio Azul works at nesting beaches, foraging grounds and aggregation sites in continental Ecuador, with special emphasis on Machalilla National Park. The Galapagos Science Center – Proyecto Tortuga Negra from San Francisco de Quito University works with hawksbills at foraging areas in the Galapagos Islands. The last two organizations are part of the Eastern Pacific Hawksbill Initiative, ICAPO.

3.5. Research

There are several research projects in continental Ecuador and Galapagos working with hawksbill sea turtles. Also, the Eastern Pacific Hawksbill Initiative (ICAPO), through its local partners – Equilibrio Azul, Ecuador Mundo Ecologico, and Galapagos Science Center-Proyecto Tortuga Negra are doing long-term research.

There are still great knowledge gaps regarding this species, especially in-water. There is data all the way back from 2008 on foraging grounds, migration routes and nesting that should be urgently published.

4. RMU: Leatherback turtle (Dermochelys coriacea) – Pacific East

4.1. Distribution, abundance, trends

4.1.1. Nesting sites

This species is extremely rare in nesting beaches; telemetry research shows that nesting females from other parts of the Eastern Pacific use Ecuadorian waters far away from the coast (37). This species is scarce in Ecuador; very few nests have been registered since constant beach monitoring started in continental Ecuador. Up to 2017, there was an average of one nest per year (28). However, during the 2020-2021 nesting season, a shocking and record-breaking total of 17 nests have been registered for this species along the continental coast of Ecuador, with one nesting female observed and tagged by members of the Refugio de Vida Silvestre Manglares del Estuario del Rio Muisne (Fig. 12) (Alemán, unpublished data; Gracia, unpublished data; Miranda & Vallejo, unpublished data, Pomilia, unpublished data; Solorzano, unpublished data; Sosa, unpublished data).

Figure 12. Leatherback (*Dermochelys coriacea*) nesting at Muisne beach during the 2020-2021 season. Photo: Ander Gracia.

Since 2014, a total of 15 beaches have registered nesting for this species (Fig. 13). None of the nests registered between 2014 and 2017 were successful.

Figure 13. Leatherback (Dermochelys imbricata) nest distribution along the Ecuadorian continental coast since 2014. (Map by Cristina Miranda).

The beach with most nests registered during the 2020-2021 period was La Playita in Machalilla National Park (Fig. 14). Equilibrio Azul has been monitoring this beach since 2007 almost every night during the hawksbill nesting season (November-April) and daily year-round; it is the first time that leatherback nests are registered in this beach with a total of four nests. Fundación Jocotoco registered three nests in Puerto Rico a few kilometers south of La Playita (Pomilia, pers.comm.). Galera San Francisco Marine Reserve staff registered two nests in Tongora, one in Coquito and one in Cabo San Francisco beach (Sosa, pers.comm.). Fundación Contamos Contigo Ecuador registered two nests in San Clemente beach, one in Chirije and one in El Balsamo beach. Finally, the Refugio de Vida Silvestre Pacoche staff registered one nest in San Lorenzo beach (Solorzano, pers.comm.) (Fig. 15). Another leatherback nesting female was spotted at Los Esteros beach, in Manta city; apparently the turtle was unable to nest and was rescued by firefighters and Ministry of Environment personnel and sent to the rehabilitation center in Machalilla National Park, where after being assessed (with x-rays showing eggs inside the body), the turtle was released immediately (Alemán, pers.comm.).

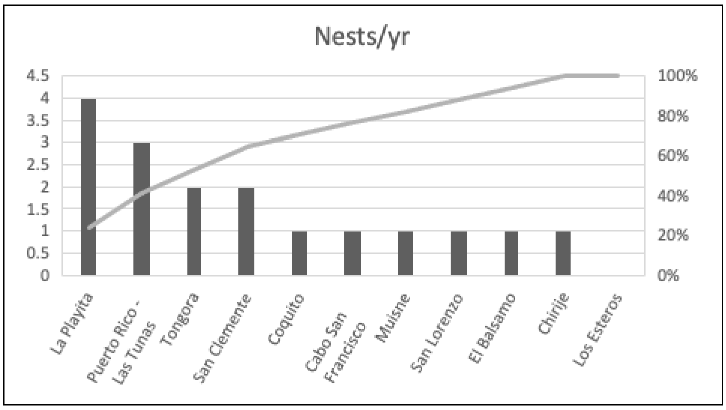

Figure 14. Number of leatherback (*Dermochelys coriacea*) nests registered per beach in continental Ecuador between 2020-2021.

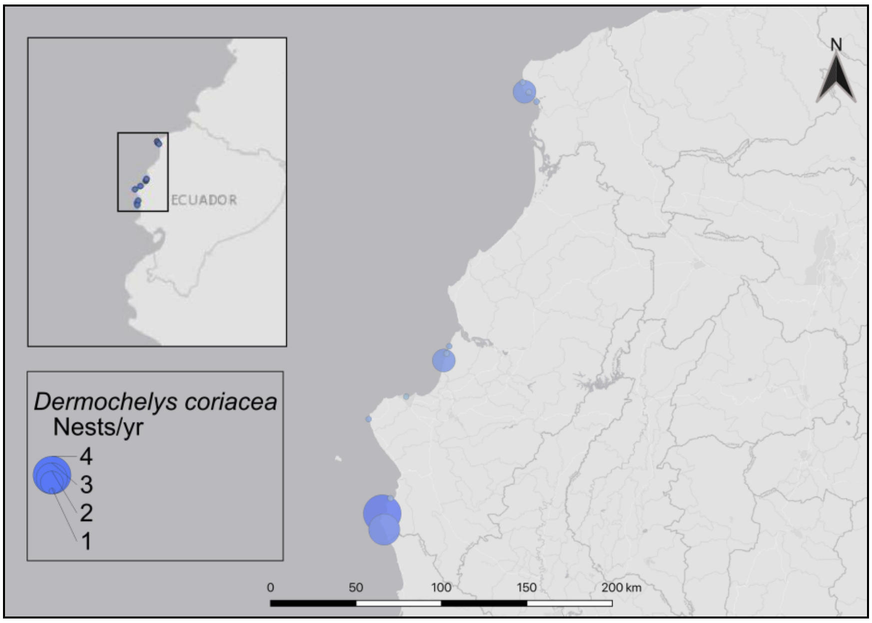

Figure 15. Leatherback (*Dermochelys coriacea*) nest distribution and abundance in continental Ecuador 2020-2021. (Map by Cristina Miranda).

From the 17 nests, despite huge efforts in protecting and monitoring them (Fig. 18), only 8 hatched successfully. Fundación Contamos Contigo Ecuador registered the first successful nests; all four nests monitored by them hatched from three different beaches (Fig. 16). The other four nests that hatched successfully were at La Playita, Machalilla National Park, where Equilibrio Azul confirmed the success upon excavating the nests (Fig 17).

Figure 16. Leatherback hatchlings racing to the ocean after hatching and Fundación Contamos Contigo Ecuador collecting data from the hatchlings in three different beaches. Photos: Fundación Contamos Contigo Ecuador volunteers.

Figure 17. Equilibrio Azul staff excavating the leatherback nests at La Playita to register success. Photos: Felipe Vallejo and Paula Holguin/Equilibrio Azul.

Figure 18. Members of the "Refugio de Vida Silvestre Manglares del Estaurio Rio Muisne" protected area protecting the leatherback nest registered at Muisne beach. Photos: Ander Gracia.

4.1.2. Marine areas

Through satellite tracking of nesting females from Central America it is known that this species uses Ecuadorian waters when migrating to southern eastern Pacific waters such as Chile (37).

However, there is also data from by-catch and interaction with fisheries for this species in Ecuadorian waters, both close to the Galapagos Islands and close to continental Ecuador. In a tri-national survey project conducted by the IUCN SSC Marine Turtle Specialist Group and NFWF, two fishing ports in Ecuador (Manta and Santa Rosa) were found to be of great significance in leatherback by-catch using gillnets and long-lines, placing Ecuador as a "high-bycatch zone"; other ports in the country were also identified to contribute to by-catch of this species such as Esmeraldas, Anconcito and Puerto Bolivar (35).

A pilot project carried out by Equilibrio Azul with artisanal fishers from Puerto López town has shown that at least 10 leatherback sea turtles are caught as bycatch every year; the project took place with a small group of only 12 fishermen and has shown that there is leatherback presence (juveniles and adults) of this species in Ecuadorian waters and sometimes close to the shore and to continental islands (Miranda et al., unpublished data).

4.3. Threats

4.3.1. Nesting sites

Although there is not much nesting activity for this species in Ecuador, habitat destruction is still a threat. The invasion of the beach with constructions, walls and boardwalks, as well as with artificial illumination and sand extraction is a problem in the entire coast.

Climate change is a great threat, as with all species, although there is no research on this subject regarding leatherback sea turtles in Ecuador.

4.3.2. Marine areas

By-catch is the greatest threat for this species in Ecuador as for the entire Eastern Pacific region. As it has been established by the LaudOPO Network (2020), if bycatch mortality is not reduced drastically, this population is facing extinction in just a few decades.

As it has been defined in the Regional Actional Plan for reversing the decline of the east Pacific leatherback, Ecuador plays an important role; the extensive size of the artisanal and industrial fishing fleet in the country poses a major threat for this species.

4.4. Conservation

As with all other sea turtle species, this species is protected under Ecuadorian laws. There is an agreement with the IACCT to promote TEDs and circle hooks with the tuna fleet, however there is no program or control to reduce by-catch with the artisanal fishery.

Ecuadorian organizations, such as Equilibrio Azul, are part of the LaudOPO (Red Laud del Océano Pacífico Oriental) network that seeks to "protect, monitor and recover the east Pacific leatherback. The Network prioritizes the reduction of bycatch in Ecuador.

Equilibrio Azul runs a project with artisanal fishermen that report any interaction with this species (and any species of sea turtles); fishermen act as the "citizen scientists" who take photos and GPS points of the location of the turtles, measurements and finally release them alive. The project also involves workshops with fishermen to find ways to reduce bycatch and its mortality, train fishermen on safe-release techniques, and find ways to help fishermen that are actively protecting leatherbacks with better access to markets. This project is funded by NFWF and Equilibrio Azul.

ProDelphinus is also developing a similar project in the southern ports of the country, working with fishermen in workshops with the aim of reducing bycatch and bycatch mortality, and trying to implement repelling techniques such as lights to avoid leatherback entanglement in gillnets.

4.5. Research

There is a huge gap in knowledge about this species in Ecuador, both in nesting activity as in-water; however, there are several projects running today (public and private) to learn more about this species in Ecuador and hopefully these knowledge gaps will be reversed on time.

5. RMU: Olive ridley turtle (*Lepidochelys olivacea*) Eastern Pacific

5.1. Distribution, abundance, trends

5.1.1. Nesting sites

This is the most abundant and common species in continental Ecuador with several index nesting beaches along the coats; it is possible that there is nesting activity of this species even on a small scale in all sandy beaches of continental Ecuador.

Up to 2017, a total of 40 beaches had been identified with nesting activity for this species, of which ten were considered index nesting beaches and an average of more than 600 nests per year (years 2014-2017) in the entire country have been registered (28).

Today, the monitoring effort has increased with more initiatives and projects patrolling beaches and registering nests for this species. In total, 51 beaches have had records of olive ridley nesting between 2018-2021, and the average has reached more than 1,000 nests per year (Fig 19). The beaches with highest abundance are San Lorenzo in the Refugio de Vida Silvestre Pacoche, followed by Same in Esmeraldas, representing together at least 30% of the total amount of nests for the country. Almost 90% of the nests of the entire country are distributed amongst 14 beaches (Fig. 18). It is possible that this numbers will continue to increase due to an increase in monitoring effort and improvements in monitoring techniques. Some of the groups that are currently monitoring beaches have little experience and require training.

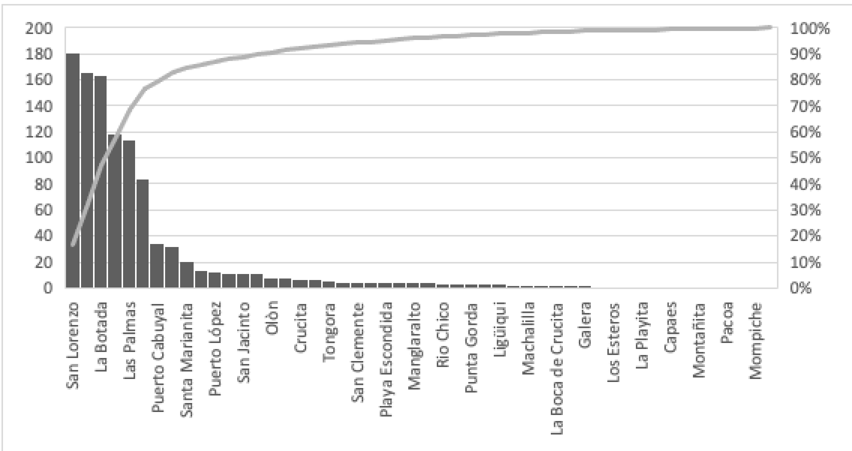

Figure 19. Number of nests per year (average between 2018-2021) per beach, for olive ridley sea turtles (*Lepidochelys olivacea*).

Although there is nesting along the entire coast and Pacoche in Manabi hold the beach with the highest number of nests, the northern province of Esmeraldas is reporting the highest density of nests along the beaches monitored (Fig 20).

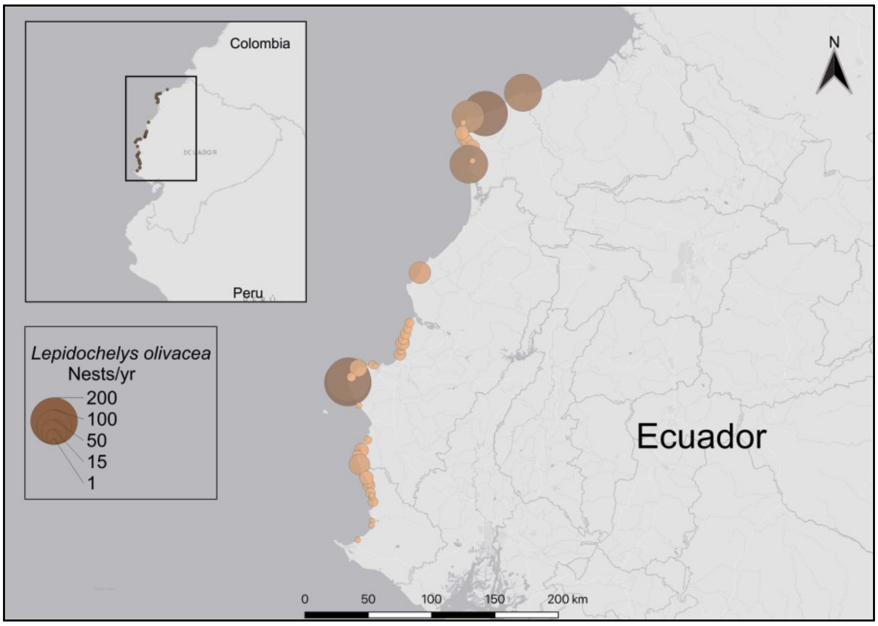

Figure 20. Map of distribution and abundance of nests in continental Ecuador for olive ridley (*Lepidochelys olivacea*) sea turtles. Map by Cristina Miranda.

5.1.2. Marine areas

No research has taken place in marine areas for this species; there is no information regarding their foraging grounds, mating areas and migratory corridors. However, this species has constant interaction with fisheries and the stranding information available suggests high in-water abundance.

Olive-ridleys are the most common specie found stranded on beaches on the entire coast. In 1999 more than 1500 individuals of this species were found stranded along the continental coast. The Ministry of Environment, through beach monitoring conducted by the Subsecretaría de Gestión Marino-Costera between 2014-2017, has reported a total of 418 olive-ridley stranding events along the coast, surely un under estimation due to lack of constant presence in all the coast. It is also the most common species at Machalilla National Park's Marine Fauna Rehabilitation Center (Alemán, pers.comm.).

5.3. Threats

5.3.1. Nesting sites

The main threats for this species' nesting sites are the following:

- Coastal development and artificial illumination
- Nest destruction by feral and domestic dogs
- Climate change and rising seas
- Removal of beach sand

Nest destruction by dogs is severely threatening the nesting success of this species. For example, in Portete, Esmeraldas province, dogs destroyed 100% of the nests prior to sea turtle conservation projects being established by Equilibrio Azul in 2011 and later continued by the Ministry of Environment of Ecuador. Other beaches such as Las Tunas, Manabi province, have around 40% of the nests destroyed by dogs. The same thing happens in Puerto Cabuyal, where 100% of the nests are destroyed by dogs, unless protected by the local community. Same beach reports the same problem. Most of the dogs that destroy nests in Ecuador are not feral but free roaming domestic pets.

Sand removal is also a great problem, as it occurs in every beach with a community or town close to it. Some beaches such as San Lorenzo in Pacoche's protected area have reduced the impact of this threat by establishing zones where the community can extract sand.

5.3.2. Marine areas

The main threat in marine-areas for this species, based on stranding information is by-catch and fishery interactions. A great percentage of the stranded olive ridleys are found with severe injuries on their skulls and carapace.

From a by-catch study conducted by Equilibrio Azul between 2009-2010, this specie interacted the most with long-line artisanal fisheries. A total of 92 olive-ridley sea turtles were caught, representing 71% of all sea turtle bycatch during the study. (16). Alfaro-Shigueto et al., (2018) reports alarming bycatch rated in Ecuador of more than 40,000 turtles caught per year, olive ridleys being the most common species.

5.4. Conservation

All sea turtles are protected in Ecuador. The main index beaches for this species are protected.

Research and nest protection conducted by the Ministry of Environment of Ecuador has proven extremely effective in their efforts to protect a great percentage of olive ridley nests in the country.

New community-based initiatives have taken place, such as the group "Reto Same" at Same beach (which reports more the 100 nests), where local people are monitoring the beach to actively protect nests. This action has proved successful during 2020.

In Puerto Cabuyal, the local school "Escuela Comunitaria Nueva Esperanza" has started monitoring the beach with the objective of not only protecting nests from dogs, but also teaching kids about the importance of sea turtles and of their conservation (Fig 21). This project is being advised by Equilibrio Azul.

a.

b.


Figure 21. Children from the Escuela Comunitaria Nueva Esperanza a.) Protecting a nest and b.) Escorting an olive ridley sea turtle back to the ocean after she nested. Photos: Alexandra García.

5.5. Research

There is little research done with this species, despite it being the most abundant species in Ecuador. Most of the monitoring is diurnal so there is little information on females, capture-recapture, clutch frequency, etc., but the work done in the last couple of years is very promising in regards of nest protection and conservation.

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Table 1. Biological and conservation information about sea turtle Regional Management Units in Ecuador.

RMU	C. caretta EP	Ref #	C. mydas EP-Continent	Ref #	C. mydas EP - Galapagos	Ref#	D. coriacea EP	Ref #	E. imbricata EP	Ref #	L. olivacea	Ref #
Occurrence												
Nesting sites	N	PS	Y		Y		Y	Ps	Y		Y	
Oceanic foraging areas	Y	4	Y		Y		Y	PS	J		Y	
Neritic foraging areas	N	PS	Y		Y		Y	PS	J/A		Y	
Key biological data												
Nests/yr: recent average (range of years)	n/r	PS	82.09 (2011; 2018-2021)	PS, 28	1032,44(2009-2013; 2015)	14, 48, 32	1.5 (2020-2021)		7.37(2018-2021)	PS	21.63(2018-2021)	PS, 24, 52, 53, 54
Nests/yr: recent order of magnitude	n/r	PS	1-48 (2011; 2018-2021)	PS, 28	7-2769 (2009-2013; 2015)	14, 48, 32	1_4	PS	1_34	PS	1-181(2018-2021)	PS, 24, 52, 53, 54
Number of "major" sites (>20 nests/yr AND >10 nests/km yr)	n/r	PS	1	28	4	14, 48, 32	0	PS	2	PS	10	PS, 24, 52, 53, 54
Number of "minor" sites (>20 nests/yr OR >10 nests/km yr)	n/r	PS	16	PS	1	14, 48, 32	11	PS	12	PS	41	PS, 24, 52, 53, 54
Nests/yr at "major" sites: recent average (range of years)	n/r	PS	48 (2011)	28	1288 (2009-2013; 2015)	14, 48, 32	0	PS	31.15(2018-2021)	PS	90.42 (2018-2021)	PS, 24, 52, 53, 54
Nests/yr at "minor" sites: recent average (range of years)	n/r	PS	34.09 (2018-2021)	PS	7 (2009-2013; 2015)	14, 48, 32	1.5 (2020-2021)	PS	3.41 (2018.2021)	PS	3.03 (2018-2021)	PS, 24, 52, 53, 54
Total length of nesting sites (km)	n/r	PS	34.44	PS	4.3	14, 48, 32	41	PS	28.31	PS	110.11 (2018-2019)	PS, 24, 52, 53, 54
Nesting females / yr	n/r	PS	n/a		2005	14, 48, 32	N		n/a		n/a	
Nests / female season (N)	n/r	PS	n/a		2.3(4769)	14, 48, 32	N		n/a		n/a	

Female remigration interval (yrs) (N)	n/r	PS	n/a		4.7(884)	14, 48, 32	N		1.9 (19)	19	n/a	
Sex ratio: Hatchlings (F / Tot) (N)	n/r	PS	n/a		n/a		N		n/a		n/a	
Sex ratio: Immatures (F / Tot) (N)	n/r	PS	n/a		n/a		N		n/a		n/a	
Sex ratio: Adults (F / Tot) (N)	n/r	PS	n/a		n/a		N		n/a		n/a	
Min adult size, CCL or SCL (cm)	n/r	PS	n/a		n/a		N		73	19	n/a	
Age at maturity (yrs)	n/r	PS	n/a		n/a		N		n/a		n/a	
Clutch size (n eggs) (N)	n/r	PS	n/a		82.9(3790)	14, 48, 32	N		159.1 (19)	19	n/a	
Emergence success (hatchlings/egg) (N)	n/r	PS	n/a		45.6(1039)	14, 48, 32	N		n/a		n/a	
Nesting success (Nests/ Tot emergence tracks) (N)	n/r	PS	n/a		0.66(16889)	14, 48, 32	N		n/a		n/a	
Trends												
Recent trends (last 20 yrs) at nesting sites (range of years)	n/r	PS	n/a		n/a		N		n/a		n/a	
Recent trends (last 20 yrs) at foraging grounds (range of years)	n/r	PS	n/a		n/a		N		n/A		n/a	
Oldest documented abundance: nests/yr (range of years)	n/r	PS	7.7 (2011-2017)	28	n/a		n/a		5(1996-1997)	40	n/a	
	n/r	PS										
Published studies												
Growth rates	N		N		Y	41	N		n/a		n/a	
Genetics	N		Y	9	Y	9, 55, 56	N		Y	20,21, 65	n/a	
Stocks defined by genetic markers	N		N		Y	56	N		Y	65	n/a	
Remote tracking (satellite or other)	N		N		Y	28, 57, 58	N		Y	18, 29, 1, 66, 67, 28, PS	n/a	
Survival rates	N		N		N		N		n/a		n/a	
Population dynamics	N		N		Y	9, 28	N		Y	68, 28	n/a	

Foraging ecology	N		n/a		Y	57, 59	N		Y	28	n/a	
Capture-Mark-Recapture	N		n/a		Y	PS, 32, 60, 41, 28	N		Y	28	n/a	
Threats												
Bycatch: presence of small scale / artisanal fisheries?	Y (PLL, DLL, SN, DN,PT,)	4, PS	n/a		Y	61	Y		Y (SN, DN, ST, MT)	28, PS	n/a	
Bycatch: presence of industrial fisheries?	Y (PLL, SN, BT)	4	Y		N		Y		n/a		n/a	
Bycatch: quantified?	N	4	N		N		Y	PS	N		n/a	
Intentional killing of turtles	N		N		N		N		Y	28	N	
Take. Illegal take of turtles	N		N		N		N		Y	28, PS	N	
Take. Permitted/legal take of turtles	N		N		N		N		N		N	
Take. Illegal take of eggs	n/a		Y	PS, 27	N		N		Y	28	Y	28
Take. Permitted/legal take of eggs	n/a		N		N		N		N		N	28
Coastal Development. Nesting habitat degradation	n/a		Y	PS, 27	Y	28	Y	PS	Y	28, 27, PS	Y	28
Coastal Development. Photopollution	n/a		Y	PS, 27	Y	28	Y	PS	Y	28, 27, PS	Y	28
Coastal Development. Boat strikes	n/a		n/a		Y	2, 62	N		Y	28, 27, PS	Y	28
Egg predation	n/a		Y	PS, 27	Y	63	N		Y	28, 27, PS	Y	PS, 28
Pollution (debris, chemical)	U		n/a		Y	2, PS	N		Y	28, PS	n/a	
Pathogens	U		n/a		Y	64	N		N		n/a	
Climate change	U		n/a		Y		Y		Y	28, PS	Y	n/a
Foraging habitat degradation	U		n/a		N		N		Y	28, PS	n/a	
Other												

Long-term projects (>5yrs)												
Monitoring at nesting sites (period: range of years)	n/a		Y (2007-2021)		Y		Y	PS	Y	28, 39, 45, 46, 47, 51, 44, 69, PS	Y	
Number of index nesting sites	n/a		1		4		0		2		10	
Monitoring at foraging sites (period: range of years)	N		Y		n/a		Y	PS	Y	28, 39, 45, 46, 47, 51, 44, 69, PS	N	
Conservation												
Protection under national law	Y		Y		Y	26	Y	26	Y		Y	
Number of protected nesting sites (habitat preservation) (% nests)	n/a		1(48)	28	n/a		n/a		2			
Number of Marine Areas with mitigation of threats	n/a		13	27	n/a		n/a		2		N	
N of long-term conservation projects (period: range of years)	N				n/a		n/a		2		Y	
In-situ nest protection (eg cages)	n/a		Y		Y		n/a		Y		Y	
Hatcheries	n/a		Y		N		n/a		Y		Y	
Head-starting	n/a		N		N		n/a		Y		N	
By-catch: fishing gear modifications (eg, TED, circle hooks)	N				N		Y	PS	N		N	
By-catch: onboard best practices	Y	4	Y		N		Y	PS	N		Y	PS
By-catch: spatio-temporal closures/reduction	N		N		N		N		N		n/a	
Other												

Table 2. Sea turtle nesting beaches in Ecuador.

RMU / Nesting beach name	Index site	Nests/yr: recent average (range of years)	Crawls/yr: recent average (range of years)	Western limit		Eastern limit		Central point		Length (km)	% Monitored	Reference #	Monitoring Level (1-2)	Monitoring Protocol (A-F)
CM-EP IND														
Portete Chico	N	1.6 (2018-2021)	n/a	-1.970962	-80.755812	-1.971814	-80.75767	-1.971522	-80.75653	0.19	100	24	1	B
Playa Rosada	N	2 (2018-2020)	n/a	-2.003455	-80.750042	-2.010113	-80.749768	-2.006525	-80.749623	0.75	100	24	1	B
Punta Blanca	N	1 (2020-2021)	n/a	-2.153067	-80.792956	-2.156365	-80.798929	-2.15472	-80.795082	0.76	80	24	2	B
Salaite	N	4 (2014)	4.7 (2008-2016)	-1.40632	-80.754453	-1.391433	-80.759474	-1.400348	-80.755621	1.77	100	44	1	B
Playa Prieta/Negra	N	-	1 (2018-2020)	-1.482821	-80.792577	-1.481871	-80.792369	-1.480918	-80.78932	0.113	100	PS	1	B
Tortuguita	N	6 (2020-2021)	6 (2020-2021)	-1.486723	-80.793107	-1.484134	-80.792567	-1.484133	-80.792536	0.347	100	PS	1	B
Los Frailes	N	1 (2014)	9.5 (2008-2011, 2014)	-1.498012	-80.797867	-1.488703	-80.793389	-1.494841	-80.793447	1.5	100	44	1	B
Puerto López	N	3.5 (2018-2020)	4 (2018-2020)	-1.562801	-80.818647	-1.530318	-80.812545	-1.547976	-80.811463	4	100	PS	1	B
La Playita	N	2 (2018-2019)	13 (2018-2019)	-1.567051	-80.83884	-1.562954	-80.835042	-1.565298	-80.836558	0.800	100	45, 46, 47, 19, PS	1	B
Salango	N	3.5 (2018-2020)	15 (2018-2020)	-1.598321	-80.8510	-1.570236	-80.840971	-1.585385	-80.84218	3.6	100	45, 46, 47, PS	1	B
Piqueros/Rio Chico	N	2 (2018-2021)	5.6 (2018-2021)	-1.6154	-80.844198	-1.603055	-80.850974	-1.608002	-80.845892	1.54	100	PS	1	B
Playa Dorada	N	1.5 (2018-2020)	1 (2018-2020)	-1.6228	-80.843	-1.61974	-80.8435	-1.6207	-80.843	0.3	100	PS	1	B

				74	368	2	5	03	44					
Puerto Rico - Las Tunas	N	1 (2019-2020)	1 (2019-2020)	-1.630507	-80.837421	-1.672608	-80.816489	-1.64894	-80.82623	4.9	50	PS	1	B
Bahía Drake, Isla de La Plata	Y	48 (2011)	168 (2009-2011)	-1.270346	-81.063053	-1.267836	-81.066363	-1.268667	-81.065682	0.47	100	15	1	B
San Lorenzo	N	1 (2018-2021)	n/a	-1.060343	-80.911913	-1.078863	-80.903003	-1.068222	-80.908196	2.2	100	PS, 24	1	B
La Botada	N	2.66 (2018-2021)	n/a	-1.043824	-80.902927	-1.053576	-80.905649	-1.048321	-80.903803	1	100	PS, 24	1	B
Santa Marianita	N	0.33 (2018-2021)	n/a	-0.958689	-80.830452	-0.973837	-80.838544	-0.965183	-80.834047	2	100	PS	1	B
Puerto Cabuyal	N	1 (2021)	n/a	-0.314973	-80.412589	-0.265878	-80.391131	-0.288243	-80.396549	6	50	PS	2	B
Galera	N	5(2020-2021)	n/a	0.815278	-80.059172	0.822466	-80.05282	0.82032	-80.05385	1.1	100	PS, 24	1	B
Quingue	N	1 (2020-2021)	n/a	0.72822	-80.09687	0.7185	-80.09488	0.71966	-80.0947	1.1	100	PS	2	B
Quinta Playa, Galapagos	Y	2769 (2009-2013; 2015)	2336.75 (2009-2013)					-1.00616	-91.081	2	100	14, 48, 32	1	B
Bahía Barahoa, Galapagos	Y	1726.5 (2009-2011)	2877 (2009-2011)					-1.001694	-91.058849	1.2	100	32	1	B
Las Bachas, Galapagos	Y	613.7 (2010, 2013, 2015)	884 (2010, 2013)					-0.494063	-90.339391	n/a	100	14, 32	1	B
Tortuga Bay, Galapagos	Y	46 (2015)	n/a					-0.761473	-90.335652	1.1	n/a	48	n/a	n/a
Punta Carola, Galapagos	N	7 (2016)	n/a					-0.88991	-89.61233	0.214	n/a	49	n/a	n/a
EI-EP IND														
Playa Rosada	Y	28.3 (2018-2021)	6 (2018-2021)	-2.003455	-80.750042	-2.010113	-80.749768	-2.006525	-80.749623	0.75	100	PS, 24	1	B
PorteteChico	N	1 (2018-2019)	n/a	-1.9709	-80.755	-1.97181	-80.7576	-1.9715	-80.756	0.19	100	PS, 24	1	B

				62	812	4	7	22	53					
Portete Grande	N	1 (2019-2020)	n/a	-1.969525	-80.752378	-1.970358	-80.754156	-1.970309	-80.753205	0.24	100	PS, 24	1	B
Portete	N	1 (2015)	n/a	0.47039	-80.053468	0.487126	-80.046194	0.48098	-80.04917	2.15	100	50	1	B
Salaite	N	1 (2013)	n/a	-1.40632	-80.754453	-1.391433	-80.759474	-1.400348	-80.755621	1.77	100	51	1	B
Playa Prieta/Negra	N	2 (2019-2020)	2 (2019-2020)	-1.482821	-80.792577	-1.481871	-80.792369	-1.480918	-80.78932	0.113	100	PS	1	B
Tortuguita	N	1 (2019-2020)	2 (2019-2020)	-1.486723	-80.793107	-1.484134	-80.792567	-1.484133	-80.792536	0.347	100	PS	1	B
Los Frailes	Y	5 (2019-2020)	3 (2019-2020)	-1.498012	-80.797867	-1.488703	-80.793389	-1.494841	-80.793447	1.5	100	PS	1	B
Puerto López	Y	5.5 (2018-2020)	6 (2019-2020)	-1.562801	-80.818647	-1.530318	-80.812545	-1.547976	-80.811463	4	100	PS	1	B
La Playita	Y	34 (2018-2020)	48.5 (2018-2020)	-1.567051	-80.83884	-1.562954	-80.835042	-1.565298	-80.836558	0.800	100	PS	1	B
Salango	N	5.5 (2018-2020)	3 (2018-2020)	-1.598321	-80.8510	-1.570236	-80.840971	-1.585385	-80.84218	3.6	100	PS	1	B
Salango Isla	Y	4 (2018-2020)	4 (2018-2020)	-1.593139	-80.863379	-1.59403	-80.861774	-1.593618	-80.862254	0.115	100	PS	1	B
Piqueros	N	2.5 (2018-2020)	3 (2018-2020)	-1.6154	-80.844198	-1.603055	-80.850974	-1.608002	-80.845892	1.54	100	PS	1	B
Playa Dorada	Y	5.5 (2018-2020)	10.5 (2018-2020)	-1.622874	-80.843368	-1.619742	-80.84355	-1.620703	-80.84344	0.3	100	PS	1	B
Puerto Rico - Las Tunas	N	7 (2018-2020)	8 (2018-2020)	-1.630507	-80.837421	-1.672608	-80.816489	-1.64894	-80.82623	4.9	50	PS	1	B
Puerto Cabuyal	N	0	1 (2021)	-0.314973	-80.412589	-0.265878	-80.391131	-0.288243	-80.396549	6	50	PS	2	B
LO-EP IND														
Las Palmas	Y	114.33 (2018-2021)	n/a	0.97224	-79.69883	0.994736583	-79.65257614	0.988515	-79.664507	5	60	PS	1	B

Same	Y	166 (2020-2021)	n/a	0.826692	-79.951758	0.852997	-79.920001	0.840767	-79.932962	4.6	100	PS	2	B
Playa Escondida	N	5 (2020-2021)	n/a	0.81759	-80.00672	0.81803	-80.00458	0.81779	-80.00601	0.2	100	PS	2	B
Galera	N	2 (2020-2021)	n/a	0.82293	-80.04928	0.81918	-80.02694	0.81858	-80.04574	3	100	PS	2	B
Galerita	Y	84 (2020-2021)	n/a	0.815278	-80.059172	0.822466	-80.05282	0.82032	-80.05385	1.1	100	PS	1	B
Tongorachi	N	3 (2020-2021)	n/a	0.66667	-80.09448	0.66397	-80.09376	0.665349	-80.093939	0.35	100	PS	2	B
Quingue	N	7 (2020-2021)	n/a	0.72822	-80.09687	0.7185	-80.09488	0.71966	-80.0947	1.1	100	PS	2	B
Tongora	N	6 (2020-2021)	n/a	0.65488	-80.0895	0.64889	-80.0872	0.653392	-80.088334	0.75	100	PS	2	B
Estero de Plátano	N	1 (2020-2021)	n/a	0.77482	-80.09141	0.77902	-80.08815	0.77724	-80.0893	0.6	100	PS	2	B
Cabo San Francisco	N	8 (2020-2021)	n/a	0.65408	-80.069475	0.645133	-80.061171	0.650175	-80.06527	1.38	100	PS	2	B
Coquito	N	11 (2020-2021)	n/a	0.70283	-80.09817	0.70367	-80.09802	0.703213	-80.098083	0.1	100	PS	2	B
Muisne	N	13.33 (2018-2021)	n/a	0.624535	-80.038104	0.5763	-80.012526	0.600847	-80.0248	5.7	100	PS	1	B
Portete	Y	118.66 (2018-2021)	n/a	0.47039	-80.053468	0.487126	-80.046194	0.48098	-80.04917	2.33	100	PS	1	B
Mompiche	N	1 (2019)		0.505193	-80.027043	0.509398	-80.020401	0.506845	-80.023491	4.19	-	PS	2	B
Puerto Cabuyal	N	35 (2020-2021)	n/a	-0.314973	-80.412589	-0.265878	-80.391131	-0.288243	-80.396549	6	50	PS	2	B
Crucita	N	7 (2020-2021)	7 (2020-2021)	-0.886891	-80549583	-0.859090	-80536440	-0.866431	-80.538776	3.45	100	PS,24	1	B
Los Arenales	N	1 (2020-2021)	1 (2020-2021)	-0.859090	-80536440	-0.848316	-80534092	-0.849796	-80.533842	1.24	100	PS,24	1	B
Los Ranchos	N	2 (2020-2021)	3 (2020-2021)	-0.8483	-805340	-0.83366	-8052894	-0.8426	-80.530	1.72	100	PS,24	1	B

				16	92	0	9	64	922					
La Gilces	N	1 (2020-2021)	1 (2020-2021)	- 0.8336 60	- 805289 49	- 0.80845 7	- 8052377 4	- 0.8203 12	- 80.525 568	2.87	100	PS,24	1	B
La Boca de Crucita	N	2 (2020-2021)	2 (2020-2021)	- 0.8084 57	- 805237 74	- 0.79896 1	- 8052257 3	- 0.8015 86	- 80.522 424	1.04	100	PS,24	1	B
San Jacinto	N	11 (2020-2021)	14 (2020- 2021)	- 0.7989 61	- 805225 73	- 0.76757 3	- 8051437 0	- 0.7856 95	- 80.518 811	3.6	100	PS,24	1	B
San Clemente	N	5 (2020-2021)	5 (2020-2021)	- 0.7675 73	- 805143 70	- 0.73324 5	- 8050516 6	- 0.7598 67	- 80.512 605	4.14	100	PS,24	1	B
El Balsamo	N	5 (2020-2021)	5 (2020-2021)	- 0.7332 45	- 805051 66	- 0.70219 3	- 8049070 2	- 0.7228 67	- 80.498 066	3.85	100	PS,24	1	B
Chirije	N	3 (2020-2021)	3 (2020-2021)	- 0.7021 93	- 804907 02	- 0.66310 9	- 8047705 0	- 0.6850 57	- 80.484 236	4.59	100	PS,24	1	B
Punta Gorda	N	3 (2020-2021)	3 (2020-2021)	- 0.6498 38	- 804732 47	- 0.63877 1	- 8046955 8	- 0.6426 31	- 80.470 581	1.33	100	PS,24	1	B
San Lorenzo	Y	181 (2018-2021)	n/a	- 1.0603 43	- 80.911 913	- 1.07886 3	- 80.9030 03	- 1.0682 22	- 80.908 196	2.2	100	PS,24	1	B
La Botada	Y	163 (2018-2021)	n/a	- 1.0438 24	- 80.902 927	- 1.05357 6	- 80.9056 49	- 1.0483 21	- 80.903 803	1	100	PS,24	1	B
Santa Marianita	N	20.33 (2018- 2021)	n/a	- 0.9586 89	- 80.830 452	- 0.97383 7	- 80.8385 44	- 0.9651 83	- 80.834 047	2	100	PS	1	B
Muerciélago	N	2 (2019)	n/a	- 0.9427 81	- 80.741 422	- 0.93587 2	- 80.7238 27	- 0.9406 14	- 80.734 706	n/a	n/a	52	2	B
San José	N	1 (2019)	n/a	- 1.2195 68	- 80.838 792	- 1.24488 3	- 80.8187 08	- 1.2303 81	- 80.829 179	n/a	n/a	52	2	B
Los Esteros	N	1 (2019)	n/a	- 0.9498 45	- 80.716 338	- 0.94982 3	- 80.7056 09	- 0.9498 02	- 80.710 641	n/a	n/a	52	2	B
Ligüiqui	N	3 (2019)	n/a	- 1.0308 6	- 80.885 515	- 1.02317 9	- 80.8805 58	- 1.0280 38	- 80.883 058	n/a	n/a	52	2	B
Salaite	N	n/a	n/a	- 1.4063 2	- 80.754 453	- 1.39143 3	- 80.7594 74	- 1.4003 48	- 80.755 621	1.77	100	51	1	B
Machalilla	N	2 (2019)	n/a	- 1.4848 98	- 80.780 11	- 1.46224 6	- 80.7640 82	- 1.4750 09	- 80.767 064	3.34	100	PS	2	B

Puerto López	Y	12 (2018-2020)	20 (2018-2020)	-1.562801	-80.818647	-1.530318	-80.812545	-1.547976	-80.811463	4	100	PS	1	B
La Playita	N	1 (2018-2020)	1 (2018-2020)	-1.567051	-80.83884	-1.562954	-80.835042	-1.565298	-80.836558	0.800	100	PS	1	B
Salango	N	4.5 (2018-2020)	8 (2018-2020)	-1.598321	-80.8510	-1.570236	-80.840971	-1.585385	-80.84218	3.6	100	PS	1	B
Piqueros/Rio Chico	N	2 (2018-2020)	8 (2018-2020)	-1.6154	-80.844198	-1.603055	-80.850974	-1.608002	-80.845892	1.54	100	PS	1	B
Puerto Rico - Las Tunas	Y	32 (2018-2020)	n/a	-1.630507	-80.837421	-1.672608	-80.816489	-1.64894	-80.82623	4.9	50	PS	1	B
Playa Bruja	N	4 (2018-2021)	n/a	-1.901961	-80.73083	-1.923312	-80.726857	-1.913808	-80.728858	2.24	100	PS, 54, 53	2	B
Capaes	N	1 (2018-2019)	n/a	-2.177123	-80.833612	-2.188639	-80.842945	-2.184417	-80.838534	1.6	100	PS, 54, 53	2	B
Libertador Bolìvar	N	1 (2018-2019)	n/a	-1.879164	-80.736201	-1.892688	-80.732976	-1.884627	-80.734489	1.63	100	PS, 54, 53	2	B
Montañita	N	1 (2018-2019)	n/a	-1.819259	-80.758192	-1.836873	-80.751017	-1.828652	-80.753534	2.19	100	PS, 54, 53	2	B
Monteverde	N	1 (2018-2019)	n/a	-2.044441	-80.736029	-2.060099	-80.736126	-2.0507	-80.735458	1.76	100	PS, 54, 53	2	B
Olòn	Y	8.3 (2018-2021)	n/a	-1.787588	-80.762711	-1.814299	-80.756863	-1.797015	-80.760292	2.98	100	PS, 54, 53	2	B
Pacoa	N	1 (2018-2020)	n/a	-2.069692	-80.737792	-2.087043	-80.742936	-2.079551	-80.740615	1.93	100	PS, 54, 53	2	B
Rio Chico	N	3.3 (2018-2021)	n/a	-1.859517	-80.743984	-1.850029	-80.747392	-1.853592	-80.746131	0.89	100	PS, 54, 53	2	B
Manglaralto	N	4 (2019-2021)	n/a	-1.844517	-80.748883	-1.858254	-80.744442	-1.850252	-80.747339	1.49	100	PS, 54, 53	2	B
Curia	N	5 (2019-2021)	n/a	-1.768224	-80.767482	-1.786528	-80.762995	-1.77705	-80.765364	2.14	100	PS, 54, 53	2	B
San Antonio	N	1 (2020-2021)	n/a	-1.87344	-80.738802	-1.865175	-80.741969	-1.86848	-80.740612	1.07	100	PS, 54, 53	2	B
San Josè	N	11 (2020-2021)	n/a	-1.7397	-80.778	-1.74620	-80.7754	-1.7430	-80.776	0.81	100	PS, 54, 53	2	B

				1	415	3	87	55	77					
DC-EP IND														
Las Palmas	N	1 (2017)	n/a	0.97224	-79.69883	0.994736583	-79.65257614	0.988515	-79.664507	5	60	PS	1	B
Tongora	N	2 (2021)	1 (2018-2019)	0.65488	-80.0895	0.64889	-80.0872	0.653392	-80.088334	0.75	100	PS	2	B
Coquito	N	1 (2021)	n/a	0.70283	-80.09817	0.70367	-80.09802	0.703213	-80.098083	0.1	100	PS	2	B
Cabo San Francisco	N	1 (2021)	n/a	0.65408	-80.069475	0.645133	-80.061171	0.650175	-80.06527	1.38	100	PS	2	B
Muisne	N	1 (2021)	n/a	0.624535	-80.038104	0.5763	-80.012526	0.600847	-80.0248	5.7	100	PS	1	B
Los Esteros	N	0 (2021)	1 (2021	-0.949845	-80.716338	-0.949823	-80.705609	-0.949802	-80.710641	n/a	n/a	PS	2	B
San Lorenzo	N	1 (2021)	n/a	-1.060343	-80.911913	-1.078863	-80.903003	-1.068222	-80.908196	2.2	100	PS,24	1	B
Puerto López	N	1 (2014)	1 (2014)	-1.562801	-80.818647	-1.530318	-80.812545	-1.547976	-80.811463	4	100	50	1	B
La Playita	N	4 (2021)	4 (2020)	-1.567051	-80.83884	-1.562954	-80.835042	-1.565298	-80.836558	0.800	100	PS	1	B
Puerto Rico - Las Tunas	N	3 (2021)	3 (2020)	-1.630507	-80.837421	-1.672608	-80.816489	-1.64894	-80.82623	4.9	50	PS	1	B
Crucita	N	1 (2017)	n/a	-0.886891	-80549583	-0.859090	-80536440	-0.866431	-80.538776	3.45	100	PS,24	1	B
San Clemente	N	2 (2020)	4 (2020)	-0.767573	-80514370	-0.733245	-80505166	-0.759867	-80.512605	4.14	100	PS,24	1	B
El Balsamo	N	1 (2020)	1 (2020)	-0.733245	-80505166	-0.702193	-80490702	-0.722867	-80.498066	3.85	100	PS,24	1	B
Chirije	N	1 (2020)	1 (2020)	-0.702193	-80490702	-0.663109	-80477050	-0.685057	-80.484236	4.59	100	PS,24	1	B

Perú

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1. RMU: Hawksbill sea turtle (*Eretmochelys imbricata*) – Eastern Pacific

1.1. Distribution, abundance, trends

1.1.1. Nesting sites

Does not apply.

1.1.2. Marine areas

The hawksbill turtle is distributed from the central coast (Ica) of Peru to Tumbes in the north, having higher concentrations in northern areas (Piura and Tumbes). Most information on the use of marine areas comes from bycatch, making it difficult to determine foraging areas or migratory corridors (see Table 1- Main Table).

The main hawksbill aggregation is found in the tropical sea ecosystem of Peru, in 3 areas: 1) From Quebrada Verde to Máncora, 2) Canoas de Punta Sal and 3) Zorritos (Ref 75). In addition, in the mixing zone between the tropical sea and the Humboldt Current, Sechura Bay hosts an important aggregation area. There are more than 10 stranding events reported inside the Virrila Estuary (05°51'S;80°59'W) (Ref 73). In the south they are rare but become more abundant during El Niño (EN) years, where more than 13 individuals were registered in EN 1987 and EN 1998 (Ref 36).

1.2. Other biological data

The size distribution for hawksbill turtles in Peru have an average CCLn-t of 40.9 cm (range 23-75.5cm, n = 69), showing an aggregation of mostly juveniles. No recaptures had been reported so estimates on growth rate or survival rates are not available.

1.3. Threats

1.3.1 Nesting sites

Does not apply.

1.3.2. Marine areas

One of the main threats for this species is the interaction with fisheries resulting in bycatch, especially in the north of Peru in set nets but there are records of bycatch in longline sets too (Fig. 3). Also, their shells are highly prized in Peru and its commercialization can still be seen in touristic places of northern Peru like Mancora (Piura). Usually, if and individual gets incidentally captured or is found stranded in the beach, its shell is likely to be kept and commercialized. In general, we know very little about this turtle in Peru so this lack of information can be considered the second main threat to its survival.

1.4. Conservation

Hawksbills are protected under national legislation and under international conventions (see Table 1 and Table 2). There are 3 National Reserves that include marine areas. In Paracas National Reserve the presence of hawksbill had been observed but in general these 3 Reserves are in the Humboldt current ecosystem (cold), therefore they do not encompass the main habitat of this species which is the Tropical marine ecosystem. The most important conservation projects with this species involves bycatch mitigation and the promotion of best practices for handling and release of turtles incidentally captured in fishing gear. In addition to this, a project using LED lights in gillnets was carried out in different fishing communities to reduce sea turtles bycatch (Ref 108). Finally, videos have been prepared on good handling and storage practices in the artisanal gillnet and longline fishery and in the industrial anchovy purse seine fishery (Ref 119, 120, 121, 122, 123).

1.5. Research

Current research with hawksbills in Peru includes monitoring of bycatch in the north of Peru, monitoring of strandings in the north of Peru, and evaluation of illegal trade (see Table 3).

2. RMU: Olive ridley sea turtle (*Lepidochelys olivacea*) – Eastern Pacific

2.1. Distribution, abundance, trends

2.1.1. Nesting sites

Currently, there are 19 nesting sites that had been reported to have had at least one olive ridley nest, hosting a small population (see Table 1- Main Table, Fig. 1 and 2). In 2019, a nest was found in a new beach in Lambayeque (El Gigante), which now is consider the LO's southernmost nesting site in Peru (Ref 117). None are index beaches, none are major sites and only 1 have regular monitoring. The averages given in the table are for all beaches combined. There is not enough information for providing trends.

2.1.2. Marine areas

Information on the use of marine areas by olive ridley comes mainly from bycatch reports. Therefore, it is hard to determine if the areas are foraging grounds or migratory corridors. In general, they are distributed along the entire Peruvian coast with a higher concentration in northern part of the coast, from the latitude 10 to the north (see Table 1- Main Table). See Fig. 3 and 4 for distribution of bycatch in pelagic longline.

In neritic areas, there are records of olive ridley bycatch in Lambayeque, Sechura Bay (Piura) and Tumbes (see Table 1- Main Table for references).

2.2. Other biological data

The average number of nests per year from all nesting beaches combined is 21.5 nests (period 2012-2019), the most recent total number of nests is 34 for 2018 (Kelez, S., 2020 pers. comm.). Only one nesting female had been measured in Peru, the curved carapace length (notch to tip) was 68.2 cm. Some individuals had been flipper tagged when captured in pelagic longline fisheries, but no recaptures had been reported so estimates on growth rate or survival rates are not available (see Table 1- Main Table).

2.3. Threats

2.3.1. Nesting sites

Main threats to nesting beaches are urban development and light pollution which reduces nesting habitat and affect its quality, the main threats to nests are predation by foxes and dogs, beach erosion and high tides (see Table 1- Main Table, Ref 58, 70).

2.3.2. Marine areas

Main threat to olive ridley is bycatch in fishing gear, especially in pelagic longlines, set nets, drift nets and pelagic trawls. There is also some degree of illegal capture and commercialization of its meat and products. Strandings of this species are more common in the north of Peru and are mainly a consequence of interactions with fisheries (see Table 1- Main Table).

2.4. Conservation

Olive ridleys are protected under national legislation and under international conventions (see Table 1 and Table 2). However, there are no nesting beaches protected in the country. There are 3 National Reserves that include marine areas, but they barely protect olive ridley because these areas are small, they are located mainly in the south of the country and also close to the coastline; while olive ridleys prefer offshore areas. The most important conservation projects for this species include the monitoring of its nesting activities and strandings (see Table 3). In the past, research was conducted on longline gear modification (circle hooks) but that is no longer in progress. In addition to this, a project using LED lights in gillnets was carried out in different fishing communities to reduce sea turtles bycatch. Finally, videos have been prepared on good handling and storage practices in the artisanal gillnet and longline fishery and in the industrial anchovy purse seine fishery (Ref 119, 120, 121, 122, 123).

2.5. Research

Current research with olive ridleys in Peru includes monitoring of nesting in the north of Peru, monitoring of strandings in the north of Peru, bycatch and illegal trade (which is conducted mainly for green turtles but some olive ridleys are also captured) (see Table 1- Main Table).

3. RMU: Green sea turtle (*Chelonia mydas)*, East Pacific

3.1 Distribution, abundance, trends

3.1.1 Nesting sites

There are 12 nesting sites, that had been reported to have had at least one East Pacific Green Turtle nest, hosting a very small population (see Table 1- Main Table, Fig. 5).

None are index beaches, none are major sites and only 2 have regular monitoring: El Bravo beach (04°02'S; 81°00'W) and Vichayito beach (04°08'S; 81°06'W) (Ref 58,68). The averages given in the table are for all beaches combined. There is not enough information for providing trends.

3.1.2 Marine areas

East Pacific Green Turtles are distributed in the entire Peruvian coastline, with highest concentration in neritic waters whiting the continental shelf. There following are the most important feeding areas, from north to south: 1)Tumbes, where large coastal areas are used by the species (03°23'S – 03°58'S) (Ref 31), 2) the northern areas of Piura, like Los Órganos (04°10'S; 81°08'W) and El Ñuro (04°13'S; 81°10'W) (Ref 40), where turtles are concentrated in the surrounding areas of fishing piers, 3) Sechura Bay, where most turtles are concentrated in the southern area with greatest concentrations in the surrounding areas of La Bocana (05°46'S; 80°52'W) and Bayovar (05°49'S; 81°02'W) (Ref 13, 20), 4) In the Virrilá estuary, turtles enters up to 20 km inshore; however, the greatest concentrations are at 8 km inshore around a shallow island (05°49'S; 80°51'W), (Ref 34, 73, 90), 5) Lobos de Tierra, a guano island, there is an important spot in the beaches located in the south east, like El Ñopo (06°27´S; 80°50'W) (Ref 37), and 6) Paracas bay which is one of the most important feeding areas in the South East Pacific, especially in La Aguada inlet (13°51'S; 76°15'W) (Ref 35,38,65,80,84) (See Fig 6, 7).

3.2 Other biological data

East Pacific green turtles size structure in Peru is constituted mainly by juveniles within the influence of the cold Humboldt current, for instance in Paracas, they have a mean CCL of 58.3 ± 7.9 (40.9-84.5 cm, n=405) (Ref 38), similarly in Lobos de Tierra the mean CCL is 57.5 ± 7.0 (26.0-74.4.5 cm, n=199) (Ref 37). Conversely, in the transition ecotone area, the size structure gradually increases from south to north, having greater percentages of sub adults and some adults, for example in Virrilá Estuary the mean CCL is 64 ± 11.5 (30.9-105.1 cm, n=1113) (Ref 36) while in El Ñuro mean CCL is 72.4 ± 10.9 (47.5-107 cm, n=228) (Ref 40). Regarding prey preferences, in Paracas they mainly prey on animal matter like sea anemones, scyphozoan jellyfishes, silverside eggs and some green and red algae (Ref 35, 38,104) while in the northern areas like Virrilá Estuary and Sechura Bay they prefer to feed on green and red algae and in less percentage on animal matter like squid eggs and fish (Ref 13, 57,105).

3.3 Threats

Based on the stranding information, anthropogenic activities, such as: by-catch, illegal direct captures and boat strike are identified as the main threats affecting the East Pacific Green Turtle population in Peruvian foraging areas. Illegal capture has been identified as the main threat affecting this species in Paracas and Virrilá Estuary and could be defined as the illicit harvesting of legally protected turtle species in order to use and benefit from the products and by-products (Ref 34). This bad practice has been reported in Peru, since 1970's. In Peru, East Pacific Green Turtles have been consumed by humans since the pre-Hispanic era. In addition, a traditional sea turtle fishery, with a well-developed trade along the southern coast existed until 1995 when this fishery was banned (Ref 35). However, carapaces are found sporadically on dump sites, suggesting that some captures still occur nowadays. Regarding boat strikes, the increasing tourism grow the risk of boat collision; this situation has been observed in Paracas due to the expansion of nautical sports and tourism (Ref 38). In the Virrilá Estuary boat strikes are due to the increase of the artisanal fishery in the Parachique area (Ref 34).

3.4 Conservation

East Pacific green turtles are Endangered according to the IUCN and Peruvian legislation (DS N° 004-2014-MINAGRI). The National Plan for the Conservation of Sea Turtles was published in 2019. This plan is a management tool that leads concrete actions for the conservation and protection of sea turtles in Peru and its habitat. The authority that lead the elaboration of the plan was the Ministry of Agriculture through the Forest and Wildlife National Service (SERFOR). Specific objectives include: (1) articulating in an appropriate way the efforts made by the state and civil society for the conservation of sea turtles in the country; (2) reducing the illegal capture of the five species of sea turtles present in Peruvian waters; (3) improving the control and monitoring systems to ensure an adequate monitoring of capture and trade of products and by-products, (4) reducing the impacts that are generated by coastal activities and (5) using LED devices in gillnets to reduce sea turtle bycatch. Finally, videos have been prepared on good handling and storage practices in the artisanal gillnet and longline fishery and in the industrial anchovy purse seine fishery (Ref 119, 120, 121, 122, 123).

3.5 Research

The East Pacific Green Turtle is the most studied species in Peru. Most of the research efforts have focused in sea turtle occurrence, population dynamics, trophic ecology, interactions between this species and local fisheries, their relationship with environmental variability and several research efforts in conservation, developed by NGO's and public institutions. However, it seems that all these efforts are not enough to translate them into concrete and effective conservation actions that help the preservation of this emblematic species.

4. RMU Leatherback sea turtle (*Dermochelys coriacea)*, East Pacific

4.1. Distribution, abundance and threats

4.1.1.Nesting sites

None.

4.1.2.Marine areas

Leatherbacks in Peru come from the nesting populations in the eastern (i.e. Costa Rica and Mexico) and western Pacific (i.e. Papua New Guinea, Indonesia and Solomon Islands). (Ref 94, 99). In the eastern Pacific Ocean, studies show that females leaving nesting beaches in central America primarily migrate southward to the southern hemisphere into the South Pacific Gyre and in pelagic waters off Peru and Chile (Ref 97).

The distribution of this species in Peru includes coastal and oceanic areas (Ref 115). The highest density of leatherbacks appears to occur in front of the northern region of La Libertad (08°14'S, 78°59'W) (see Table 1- Main Table, Ref 22). In addition, other hot-spots are in shallow waters off Tumbes (03°23'S; 80°18'W – 03°51'S; 80°50'W) and in the central and southern area between Cerro Azul (13°01'S; 76°29'W) and Paracas (13°50'S; 76°15'W), with the highest concentrations in the surrounding areas of Tambo de Mora (13°27'S; 76°11'W) (Ref 42, 81). Other important area is off Lambayeque, mainly between Lobos de Tierra Island (06°26'W; 80°51'W) and Punta Chérrepe (07°10'S; 79°41'W) (Ref 79,106).

4.2. Other biological data

Leatherbacks captured in Peruvian waters have a mean CCL of 115.3 ± 17.7 (80-136 cm, n=13). The contents of three stomachs were analyzed and almost 100% of the diet was the scyphozoan jellyfish *Chrysaora plocamia.* Food availability (represented by the abundances of the jellyfish *C. plocamia* in the area) together with environmental variability driven by warm water intrusions resulting from Kelvin waves, seem to strongly influence the coastal distribution of juvenile and sub-adult leatherbacks in Peruvian waters (see Table 1- Main Table for references).

4.3. Threats

4.3.1.Nesting sites

Does not apply.

4.3.2.Marine areas

Their main threat is incidental capture in fishing gear (e.g. gillnets and longlines). Published data showed the incidental capture of 133 turtles between 2000 and 2003 (Ref 22) and the capture of 70 leatherbacks in driftnets and longline fisheries in the period from 2000 to 2007 (Ref 5).

4.4. Conservation

Leatherback sea turtles of the Eastern Pacific population are Critically Endangered, according to the IUCN. However, in Peru they are categorized as Endangered (DS N° 004-2014-MINAGRI). The Peruvian government banned the direct capture of all marine turtle species in Peruvian waters under the Ministerial Resolution No. 103-95-PE. Subsequently, Supreme Decree No. 026-2001-PE maintains this prohibition and the Supreme Decree No. 034-2004-AG approves the categorization of endangered wild fauna and flora species, and bans their hunting, capture, possession, transport and export for commercial purposes. Under the protection of the Criminal Code (Title XIII) illegal trafficking of this species is punishable by imprisonment. As well, its extraction, transport or storage is considered a serious infraction (Supreme Decree N ° 016-2007-PRODUCE).

The National Plan for the Conservation of Sea Turtles was approved and published in 2019 by the Agriculture Ministry (MINAGRI). The Plan is focused in bycatch reduction and mitigation, direct capture reduction, habitat conservation, tourism management and environmental education as well as inter-institutional collaboration and capacity building. In addition to this, a project using LED lights in gillnets was carried out in different fishing communities to reduce sea turtles bycatch. Finally, videos have been prepared on good handling and storage practices in the artisanal gillnet and longline fishery and in the industrial anchovy purse seine fishery (Ref 119, 120, 121, 122, 123).

4.5. Research

Most of the research efforts have focused in the interactions between leatherbacks and local fisheries in Peru. As a result, information on basic ecology of the species is still missing, as well as information on habitat use and residency of juveniles in the area. Finally, despite the efforts of national and independent institutions to conduct research and monitoring programs alongside the Peruvian coastline, most of the existing information remains unpublished.

5. RMU Loggerhead sea turtle (*Caretta caretta*), East Pacific

5.1. Distribution, abundance, trends

5.1.1 Nesting sites

None.

5.1.2 Marine areas

The predominant presence of juvenile loggerhead sea turtles in Peru (Ref 1) and the absence of individuals smaller than 70 cm long in Australia (Ref 100), suggest that Peruvian waters are developmental grounds, as well as foraging habitat for this species (Ref 4).

The presence of loggerhead sea turtles in Peru have been recorded between 5°-22°S and 71°- 90°W, and 46.5 to 637.1 km from the coast (Ref 1, 3, 66). These records support the findings of stable isotopes analyses, which reveal an oceanic feeding behavior. Moreover, these findings have been verified through satellite tracking (Ref 3). See Fig 3, 4 and 8 for distribution of bycatch in pelagic longlines.

5.2. Other biological data

Genetic studies indicate that the population of *Caretta caretta* in Peru comes from nesting populations of eastern Australia and New Caledonia (Ref 59, 99). Loggerheads in Peru have been reported with a mean CCL ± SD of 57.2 ± 9.18 cm (35.9 - 86.3 cm, n= 307) (Ref 1). However, as this study depended on captured sea turtles, it only represents the size of turtles vulnerable to longline and gillnet bycatch.

Research on foraging ecology has only been conducting with stable isotope analysis. The studies show that this species has an oceanic feeding behavior and an intermediate trophic level in Peruvian waters (Ref 3, 72).

Juvenile loggerhead turtles tracked with satellite transmitters (post capture in longline fishing gear) spent ca. 51% of their time in Peruvian waters, 39% in international waters and 9% in Chilean waters (Ref 3).

5.3. Threats

5.3.1 Nesting sites

Does not apply.

5.3.2 Marine areas

The main threat for this species in Peru is bycatch in artisanal longline fisheries of Mahi Mahi and shark (Ref 1, 5, 21, 48, 66). In that sense, a study highlighted an overlap between the distribution zone of sea turtles and the fishing areas used by the mahi-mahi artisanal fishing fleet (Ref 3).

5.4 Conservation

Under Ministerial Resolution No. 103-95-PE, the direct capture of all species of marine turtles in Peruvian waters, including *C. caretta*, is prohibited. Subsequently, Supreme Decree No. 026-2001-PE maintains this prohibition and Supreme Decree No. 034-2004-AG approves the categorization of endangered wild fauna and flora species, and prohibits their hunting, capture, possession, transport and export for commercial purposes. Under the protection of the Criminal Code (Title XIII) illegal trafficking of this species is punishable by imprisonment. As well, its extraction, transport or storage is considered a serious infraction (Supreme Decree N ° 016-2007-PRODUCE).

The species is listed as endangered (D.S. N° 004-2014-MINAGRI) (Ref 101), this being approved at the national level with the updating of the classification and categorization list of legally protected wildlife species. It should be noted that Peru is part of the Convention on Biological Diversity (CBD) and the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC).

As part of the projects developed for its conservation, a circular hook interchange program was carried out to reduce its bycatch in the artisanal longline fishery (Ref 6, 102). However, currently this program is no longer in development. In recent years, tools and good practices for the recovery, handling and release of bycatch turtles in fishing nets have been used, which are available in manuals and have been applied in the field (Ref 6, 7).

Finally, videos have been prepared on good handling and storage practices in the artisanal gillnet and longline fishery and in the industrial anchovy purse seine fishery (Ref 119, 120, 121, 122, 123).

5.5 Research

Filling information gaps is a priority for this species, such as bycatch rates, assessment of injuries produced due to fishing interactions, post-release survival rates, trophic ecology and habitat use in the overlapping area with fisheries (tagging, satellite transmitters).

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Table 1. Biological and conservation information about sea turtle Regional Management Units in Peru.

RMU	Ei-EPO	Ref #	Lo-EPO	Ref #	Dc-EPO	Ref #	Cc-EPO	Ref #	Cm-EPO	Ref #
Occurrence										
Nesting sites	N		Y	18, 28, 29, 47, 49, 50, 58, 61, 68, 70, 78, 103	N		N		Y	33, 58, 61, 68, 70, 78, 88, 109
Pelagic foraging grounds	Y	6	Y	5, 6, 12, 46, 48, 51, 69, 72	Y	5, 6, 12, 22, 46, 48, 69, 72, 87, 97, 98, 103, 110, 115	Y	1, 2, 3, 4, 5, 6, 12, 43, 46, 48, 51, 69, 72, 100	Y	5, 6, 12, 46, 48, 51, 69, 72
Benthic foraging grounds	Y	9, 17, 20, 31, 36, 40, 74, 75, 77	Y	5, 9, 20, 27, 31	Y	22, 31, 87, 103, 115	N		Y	5, 9, 13, 20, 31, 34, 37, 39, 40, 80, 84, 90, 103, 109
Key biological data										
Nests/yr: recent average (range of years)	N		21.5 average (2012-2019)	Kelez, S., 2020 pers. comm.	N		N		3.4 average (2012-2018)	Kelez, S., 2019 pers. comm.
Nests/yr: recent order of magnitude	N		34 (2018)	Kelez, S., 2019 pers. comm.	N		N		7 (2018)	Kelez, S., 2019 pers. comm.
Number of "major" sites (>20 nests/yr AND >10 nests/km yr)	NA		NA		NA		NA		NA	
Number of "minor" sites (<20 nests/yr OR <10 nests/km yr)	N		18	Kelez, S., 2020 pers. comm.	N		N		12	Kelez, S., 2019 pers. comm.
Nests/yr at "major" sites: recent average (range of years)	NA		NA		NA		NA		NA	
Nests/yr at "minor" sites: recent average (range of years)	N		21.5 average (2012-2019)	Kelez, S., 2020 pers. comm.	N		N		3.4 average (2012-2018)	Kelez, S., 2019 pers. comm.
Total length of nesting sites (km)	N		N		N		N		N	
Nesting females / yr	N		N		N		N		N	
Nests / female season (N)	N		N		N		N		N	
Female remigration interval (yrs) (N)	N		N		N		N		N	
Sex ratio: Hatchlings (F / Tot) (N)	N		N		N		N		N	
Sex ratio: Immatures (F / Tot) (N)	N		N		N		N		N	

Sex ratio: Adults (F / Tot) (N)	N		N		N		N		N	
Min adult size, CCL or SCL (cm)	N		68.2 cm CCLnt	Kelez, S., 2019 pers. comm.	N		N		N	
Age at maturity (yrs)	N		N		N		N		N	
Clutch size (n eggs) (N)	N		N		N		N		N	
Emergence success (hatchlings/egg) (N)	N		N		N		N		N	
Nesting success (Nests/ Tot emergence tracks) (N)	N		N		N		N		N	
Trends										
Recent trends (last 20 yrs) at nesting sites (range of years)	N		N		N		N		N	
Recent trends (last 20 yrs) at foraging grounds (range of years)	N		N		N		N		N	
Oldest documented abundance: nests/yr (range of years)	N		N		N		N		N	
Published studies										
Growth rates	N		N		N		N		Y	34, 40, 84, 114
Genetics	Y	76	Y	49, 52, 53	Y	94, 99	Y	2, 52, 53, 59, 99	Y	52, 53, 71, 99
Stocks defined by genetic markers	Y	76	Y	49, 52, 53	Y	94, 99	Y	2, 52, 53, 59, 99	N	52, 53, 71, 99
Remote tracking (satellite or other)	Y	77	N		Y	96, 97, 98	Y	3	N	
Survival rates	N		N		N		N		N	
Population dynamics	N		Y	67	Y	79, 110, 111	N		Y	35, 40, 84
Foraging ecology (diet or isotopes)	N		Y	65, 72, 91	Y	79, 110	Y	4, 72	Y	13, 35, 39, 45, 57, 63, 65, 72, 80, 89, 103, 104, 105, 107, 116
Capture-Mark-Recapture	N		N		N		N		Y	34, 39, 40, 80, 84, 105, 114
Threats										
Bycatch: presence of small scale / artisanal fisheries?	Y (PLL, SN, DN, coastal rafts, purse seine)	6, 9, 17, 20, 21, 26, 27, 31, 38, 66, 67, 77, 95	Y (PLL, SN, DN, PT)	5, 6, 9, 12, 20, 21, 27, 31, 38, 41, 46, 48, 51, 65, 66, 67, 69, 95, 118	Y(PLL, SN, DN)	5, 6,12, 21, 22, 31, 38, 42, 46, 48, 55, 65, 66, 69, 79, 81, 87, 93, 95, 106, 110, 111, 115	Y (PLL, DN, gillnets)	1, 2, 3, 5, 6,12, 21, 43, 46, 48, 51, 55, 66, 69	Y(PLL, SN, DN, ST)	5, 6, 9, 12, 20, 21, 31, 38, 46, 48, 51, 55, 65, 66, 67, 69, 95, 103, 112, 118
Bycatch: presence of industrial fisheries?	N		N		Y	42, 110	N		N	

Bycatch: quantified? (Yes/No or turtles/year)	N		140 (PLL ref 5), 47(SN ref 5), 16.5 (SN ref 20), 60 (DN ref 5), N(PT)	5, 20	70 (PLL + DN, ref 5)	5, 115	3200 (PLL + DN, ref 5)	5	2400 (PLL + SN + DN, ref 5)	5
Take. Intentional killing or exploitation of turtles	Y	26, 36, 38, 44	Y	5, 31, 32, 38, 41, 65, 82, 83, 85, 95, 113	Y	5, 22, 31, 38, 42, 65, 79, 85, 93, 113	Y	5	Y	5, 11, 18, 31, 34, 37, 38, 60, 65, 73, 82, 83, 85, 95, 103, 109, 113
Take. Illegal take of turtles	N		Y	38, 60, 65, 82, 83, 85						
Take. Permitted/legal take of turtles	N		N							
Take. Illegal take of eggs	N		Y	49, 58	N		N		N	
Take. Permitted/legal take of eggs	N		N							
Coastal Development. Nesting habitat degradation	N		Y	28, 58, 78	N		N		Y	58, 78
Coastal Development. Photopollution	N		Y	58, 78	N		N		Y	58, 78
Coastal Development. Boat strikes	N		Y	31, 41, 113	N	113	N		Y	31, 34, 38, 65, 73, 113
Egg predation	N		Y	58	N		N		Y	58
Pollution (debris, chemical)	N		N		N		Y	Zambrano, M., 2019 pers. comm.	Y	13, 34, 39, 45, 57, 65, 89, 92, 95
Pathogens	N		N		N		N		Y	23, Bachmann, V. 2018 pers. comm.
Climate change	N		N		Y	79	N		Y	35
Foraging habitat degradation	N		N		N		N		Y	45, 65
Parasites / Simbiots	N		N		N		Y	19	Y	25, 39, 80, 86, 103
Strandings	Y	27, 34, 62, 73	Y	27, 31, 32, 41, 44, 54, 85, 109, 113	Y	27, 31, 42, 54, 85, 113	N		Y	27, 31, 34, 38, 44, 54, 62, 73, 85, 109, 113
Long-term projects										
Monitoring at nesting sites	N		Y	58, 68, 78	N		N		Y	58, 68, 78
Number of index nesting sites	NA		NA		NA		NA		NA	
Monitoring at foraging sites	N		N		N		N		Y	13, 34, 39, 80, 84
Conservation										
Protection under national law	Y	8,10, 64, 101	Y	8, 10, 64, 101	Y	8,10, 64,	Y	8,10,64, 101	Y	8, 10, 64, 101

						101				
Number of protected nesting sites (habitat preservation)	NA		0		NA		NA		0	
Number of Marine Areas with mitigation of threats	3	14, 15, 16	3	14, 15, 16	N		N		3	14, 15, 16
Long-term conservation projects (number)	6	Pro Delphinus, ecOceanica, IMARPE, SERFOR, SERNANP, WWF Perú	6	WWF-Perú, Pro Delphinus, ecOceanica, IMARPE, SERFOR, SERNANP	7	WWF-Perú, Pro Delphinus, ecOceanica, IMARPE, SERFOR, SERNANP, ACOREMA	7	WWF-Perú, Pro Delphinus, ecOceanica, IMARPE, SERFOR, SERNANP, ACOREMA	7	WWF-Perú, Pro Delphinus, ecOceanica, IMARPE, SERFOR, SERNANP, ACOREMA
In-situ nest protection (egg cages)	N		N		N		N		N	
Hatcheries	N		N		N		N		N	
Head-starting	N		Y	50	N		N		N	
By-catch: fishing gear modifications (eg, TED, circle hooks)	Y (circle hooks, LED lights)	6, 9, 66	Y(circle hooks, LEDs)	6, 66, 102, 108	Y(circle hooks, LED lights)	6, 66, 108	Y(circle hooks)	6, 66, 102	Y (circle hooks, LEDs, pingers)	6, 9, 56, 66, 102, 108
By-catch: onboard best practices	Y	6, 7, 66, 119, 120, 121, 122, 123	Y	6, 7, 12, 66, 119, 120, 121, 122, 123	Y	6, 7, 12, 55, 66, 106, 119, 120, 121, 122, 123	Y	6, 7, 12, 55, 66, 119, 120, 121, 122, 123	Y	6, 7, 12, 55, 56, 66, 119, 120, 121, 122, 123
By-catch: spatio-temporal closures/reduction	N		N		N		N		N	
Hibridization	Y	24	N		N		N		Y	24
Health	N		N		N		N		Y	23
Gaps	N		N		N		N		N	
Research	Y	Current research: strandings, bycatch	Y	Current research: population dynamics, strandings, trophic ecology, genetics, nesting and stable isotops	Y	Current research: strandings, bycatch	Y	Current research: strandings, bycatch	Y	Current research: population dynamics, strandings, trophic ecology, genetics, nesting and stable isotops

Table 2. International conventions protecting sea turtles and signed by Peru.

International Conventions	Signed	Binding	Compliance measured and reported	Species	Conservation actions	Relevance to sea turtles
Inter - American Convention for the Protection and Conservation of Sea Turtles (CIT)	Y	Y	Y	ALL	Resolutions for: 1) the conservation of the hawksbill turtle, 2) the east pacific leatherback turtle, 3) the loggerhead turtle, 4) the promotion of sustainable fishing in international waters, especially for the protection of sea turtles, 5) the adaptation of sea turtle habitats to climate change, 6) reduction of the adverse impacts of fisheries on sea turtles	It is specific for sea turtles
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	Y	Y	Y	ALL	Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.	Bans trade of sea turtles and their parts/products

Convention on the Conservation of Migratory Species of Wild Animals (CMS)	Y	Y	Y	ALL	CMS provides a global platform for the conservation and sustainable use of migratory animals and their habitats. Brings together the States through which migratory animals pass, the Range States, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range.	Provides funding for conservation research, developed the Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia (IOSEA), it has a specific resolution on bycatch detailing various actions needed to reduce bycatch of migratory species that will include marine turtles (UNEP/CMS/Resolution 9.18 on Bycatch).
South Pacific Permanent Comission (CPPS)	Y		Y	ALL		Marine environmental policies
Agreement for the protection of the marine environment and the coastal zone of the Southeast Pacific	Y			ALL		Marine protected areas
Protocol for the Conservation and Management of Marine and Coastal Protected Areas of the Southeast Pacific	Y			ALL		Marine protected areas
Convention on Biological Diversity	Y	Y	Y	ALL		Environmental protection

Table 3. Projects on sea turtles in Peru.

RMU	Country	Region / Location	Project Name or descriptive title	Key words	Start date	End date	Leading organisation	Public/Private	Collaboration with	Current Sponsors	Primary Contact (name and Email)
CM-EPO, EI-EPO, CC-EPO, DC-EPO, LO-EPO	Peru	Parachique (Piura)	Monitoreo de Parámetros Biológicos, poblacionales, sanitarios y Ecología alimentaria de las tortugas marinas en el estuario de Virrilá, Piura.	Monitoring, populations, sea turtles, ecology, Peru - Virrilá Estuary	2012	2018	IMARPE	Public	-	State	Javier Quñones (jquinones@imarpe.gob.pe)
CM-EPO, EI-EPO, CC-EPO, DC-EPO, LO-EPO	Peru	Parachique (Piura)	Estimación de la mortandad de tortugas marinas en el estuario de Virrilá.	Monitoring, populations, sea turtles, mortality, Peru - Virrilá Estuary	2012	2018	IMARPE	Public	-	State	Javier Quñones (jquinones@imarpe.gob.pe)
CM-EPO, EI-EPO, CC-EPO, DC-EPO, LO-EPO	Peru	Tumbes, Piura y Lambayeque	Monitoreo de eventos de varamiento de fauna marina en la costa de Tumbes, Piura y Lambayeque	sea turtles, mortality, strandings, peruvian coast	2014	In progess	IMARPE	Public	-	State	Javier Quñones (jquinones@imarpe.gob.pe)

CM-EPO	Peru	Parachique (Piura) y Paracas (Ica)	Proyecto: Caracterización de la variabilidad genética poblacional de la tortuga verde en el Estuario de Virrilá y Paracas	sea turtles, population ecology, Peru - Virrilá Estuary, green turtles	2012	2017	IMARPE	Public	-	State	Javier Quñones (jquinones@imarpe.gob.pe)
CM-EPO, EI-EPO, CC-EPO, DC-EPO, LO-EPO	Peru	Tumbes	Proyecto: Captura Incidental de tortugas marinas en la pesca artesanal de enmalle de la región Tumbes.	bycatch, sea turtles, SSF, gillnets, Tumbes	2006	In progess	IMARPE	Public	-	State	Javier Quñones (jquinones@imarpe.gob.pe)
CM-EPO, EI-EPO, CC-EPO, DC-EPO, LO-EPO	Peru	Costa peruana	PLAN NACIONAL DE CONSERVACIÓN DE LAS TORTUGAS MARINAS EN EL PERÚ	Conservation, sea turtles, strategy, Peru	2019	2029	SERFOR	Public	MINAM, PRODUCE, IMARPE, SERNANP y sociedad civil	State	Jessica Galvez (jgalvez@serfor.gob.pe)
CM-EPO, EI-EPO, CC-EPO, DC-EPO, LO-EPO	Peru	Tumbes, Pucusana, Ica e Ilo	Talleres capacitación en correctas medidas de manipulación y liberación de tortugas marinas en las redes de pesca y espinel artesanal. Registro de varamientos en las regiones de Tumbes e Ica.	Workshops, sea turtles, SSF, handling and release	2016	In progess	ACOREMA	Private	WWF Peru	WWF	Nelly de Paz Campos (nellydepazcampos@gmail.com)
CM-EPO, EI-EPO, CC-EPO, DC-EPO, LO-EPO	Peru	Tumbes e Ica	Monitoreo de la captura incidental de tortugas marinas en la pesca de enmalle de la región Ica y Tumbes a través de observadores a bordo y en colaboración con pescadores artesanales.	Monitoring, sea turtles, bycatch, gillnets	2006	In progess	ACOREMA	Private	SWFSC/NOAA	SWFSC/NOAA	Nelly de Paz Campos (nellydepazcampos@gmail.com)
CM-EPO, EI-EPO, CC-EPO, DC-EPO, LO-EPO	Peru	Máncora (Piura), San José (Lambayeque), Salaverry (La Libertad)	Programa de observadores abordo en embarcaciones artesanales en Perú.	Monitoring, sea turtles, bycatch, SSF, onboard observer	2010	In progess	ProDelphinus	Private	NFWF	NFWF	Joana Alfaro-Shigueto (joanna@prodelphinus.org)

DC-EPO	Peru	San José (Lambayeque) y Chorrillos (Lima)	Proyecto enfocado en la conservación de la población tortugas laúd (Dermochelys coriacea) del Pacifico Este.	Conservation, leatherback sea turtle, strategies, Eastern Pacific	2016	In progess	ProDelphinus	Private	NFWF & Laud OPO Network	NFWF & Laud OPO Network	Joana Alfaro-Shigueto (joanna@prodelphinus.org)
CM-EPO, EI-EPO, CC-EPO, DC-EPO, LO-EPO	Peru	Costa peruana	Proyecto de fortalecimiento de capacidades para la promoción de pesca sostenible en el sector pesquero industrial de anchoveta.	Susteinability, conservation, megafauna, bycatch, anchovy fishery	2014	In progess	ProDelphinus	Private	TASA (Tecnológica de Alimentos S.A) y PNIPA	TASA (Tecnológica de Alimentos S.A) y PNIPA	Joana Alfaro-Shigueto (joanna@prodelphinus.org)
CC-EPO	Peru	Ilo (Moquegua)	Programa de monitoreo de la captura incidental de tortugas marinas con enfoque tortugas cabezonas (*Caretta caretta*) en la pesquería artesanal de palangre en Ilo.	Monitoring, loggerhead sea turtle, bycatch, SSF, longlines	2017	In progess	ProDelphinus	Private	NFWF	NFWF	Joana Alfaro-Shigueto (joanna@prodelphinus.org)
CM-EPO, EI-EPO, CC-EPO, DC-EPO, LO-EPO	Peru	Trujillo (La Libertad)	Monitoreo de eventos de varamiento y mortandad de fauna marina, en las playas de la provincia de Trujillo, región La Libertad.	sea turtles, mortality, strandings, beaches, Trujillo	2016	In progess	GRAM- Trujillo	Private	IMARPE, SERFOR	CONSERVACCION	Carlos Calvo Mac (calo.25388@gmail.com)
CM-EPO, EI-EPO	Peru	Los Órganos y el Ñuro	Programa de monitoreo poblacional de tortugas marinas en el norte de Perú.	In-water surveys,Chelonia mydas, conservation, northern peru	2010	In-progress	EcOceania	Private	Asociación de pescadores	-	Carmen Rosa Gonzalez (carmen.gonzalez@ecoceanica.org)
CM-EPO, EI-EPO, CC-EPO, DC-EPO, LO-EPO	Peru	Los Órganos y el Ñuro	Programa de monitoreo de varamientos de tortugas marinas en el norte de Perú.	sea turtles, northern peru, strandings,conservation	2010	In-progress	EcOceania	Private	SERFOR	-	Carmen Rosa Gonzalez (carmen.gonzalez@ecoceanica.org)
CM-EPO, LO-EPO	Peru	Norte peruano (Piura y Tumbes)	Programa de investigación y conservación de actividad de anidación de tortugas marinas en Perú.	sea turtles, northern peru, nesting,conservation, olive ridley, Chelonia mydas	2010	In-progress	EcOceania	Private	Red de Conservación de Tortugas Marinas	-	Carmen Rosa Gonzalez (carmen.gonzalez@ecoceanica.org)

CM-EPO, EI-EPO, CC-EPO, DC-EPO, LO-EPO	Peru	Cancas y Punta Mero	Proyecto de mitigación y monitoreo de la captura incidental de tortugas marinas con luces LED en redes de enmalle de la costa norte del Perú	Artisanal fisheries, bycatch, fisheries management, sea turtles, gillnets, led lights	2021	In-progress	ecOceanica	Private	WWF	SWOT	Carmen Rosa Gonzalez (carmen.gonzalez@ecoceanica.org)
EI-EPO	Peru	Norte peruano (Piura y Tumbes)	Proyecto de biología y ecología de la tortuga carey (Eretmochelys imbricata) en el norte del Perú.	hawksbill turtle,conservation, ecology, northern Peru,critically endangered, marine conservation	2017	In-progress	ecOceanica	Private	Asociación de pescadores	-	Carmen Rosa Gonzalez (carmen.gonzalez@ecoceanica.org)
CM-EPO, EI-EPO, CC-EPO, DC-EPO, LO-EPO	Peru	Tambo de Mora, Pucusana, Salaverry, Zorritos, Acapulco, La Cruz	Reducing Turtle Bycatch in the Eastern Pacific	LED lights, sea turtles, SSF	2016	In progess	WWF Peru	Private	ProDelphinus, Acorema, IMARPE, RED SOS	Montagu & Persephone	Evelyn Luna-Victoria (evelyn.lunavictoria@wwfperu.org)
CM-EPO, EI-EPO, CC-EPO, DC-EPO, LO-EPO	Peru	San José	Local assembled LED devices, a big step to adress sea turtles bycatch in Peru	LED lights, assembled, cooperatives	2018	2020	WWF Peru	Private	San Jose Cooperative	Restore our Planet	Evelyn Luna-Victoria (evelyn.lunavictoria@wwfperu.org)
CM-EPO, EI-EPO, CC-EPO, DC-EPO, LO-EPO	Peru	Tambo de Mora, Pucusana, Salaverry, Zorritos, Acapulco, La Cruz	Conserving the marine ecosystem guardians: a safe release future for Sea Turtles	sea turtles, marine education, policy, guidelines	2020	In progess	WWF Peru	Private	IMARPE, RED SOS, Minedu, Produce, SERFOR	Montagu & Persephone	Evelyn Luna-Victoria (evelyn.lunavictoria@wwfperu.org)
CM-EPO, EI-EPO, CC-EPO, DC-EPO, LO-EPO	Peru	Costa peruana	Proyecto de gestión pesquera sostenible-CUIDAMAR. Conservación de tortugas marinas	Susteinability, conservation, megafauna, bycatch, anchovy fishery	2008	In progess	TASA (Tecnológica de Alimentos S.A)	Private	ProDelphinus e IMARPE	TASA (Tecnológica de Alimentos S.A) y PNIPA	Área de comunicaciones (comunicaciones@tasa.com.pe)

Table 4. Databases on sea turtles in Peru.

Database available	Name of Database	Names of sites included (matching Table B, if appropriate)	Beginning of the time series	End of the time series	Track information	Nest information	Flipper tagging	Tags in STTI-ACCSTR?	PIT tagging	Remote tracking
Y	ElNuro_seaturtles & LosOrganos_seaturtles	El Ñuro y Los Organos	2010	2019	N	N	Y	N	Y	N
y	Varamientos Peru 2018-2021	Zorritos, Acapulco, Punta Mero, Mancora, San andres,Bonanza, Caleta Grau,Negritos,El Nuro y Los Organos	2000	2021	N	N	Y	N	N	N
Y	Anidaciontortugas	El Bravo, Mancora,Los Organos, Pocitas, Vichayito, Lobitos	2010	2021	N	Y	Y	N	N	N
Y	Carey_basedatosecO	Zorritos, Acapulco, Punta Mero, Mancora, Bahia Paracas,Bonanza,El Nuro y Los Organos	2001	2021	N	N	Y	N	N	N

Figure 1. Olive ridley nesting sites (Kelez, S., 2019 pers. comm., map elaborated by Carmen Rosa Gonzalez, 2019).

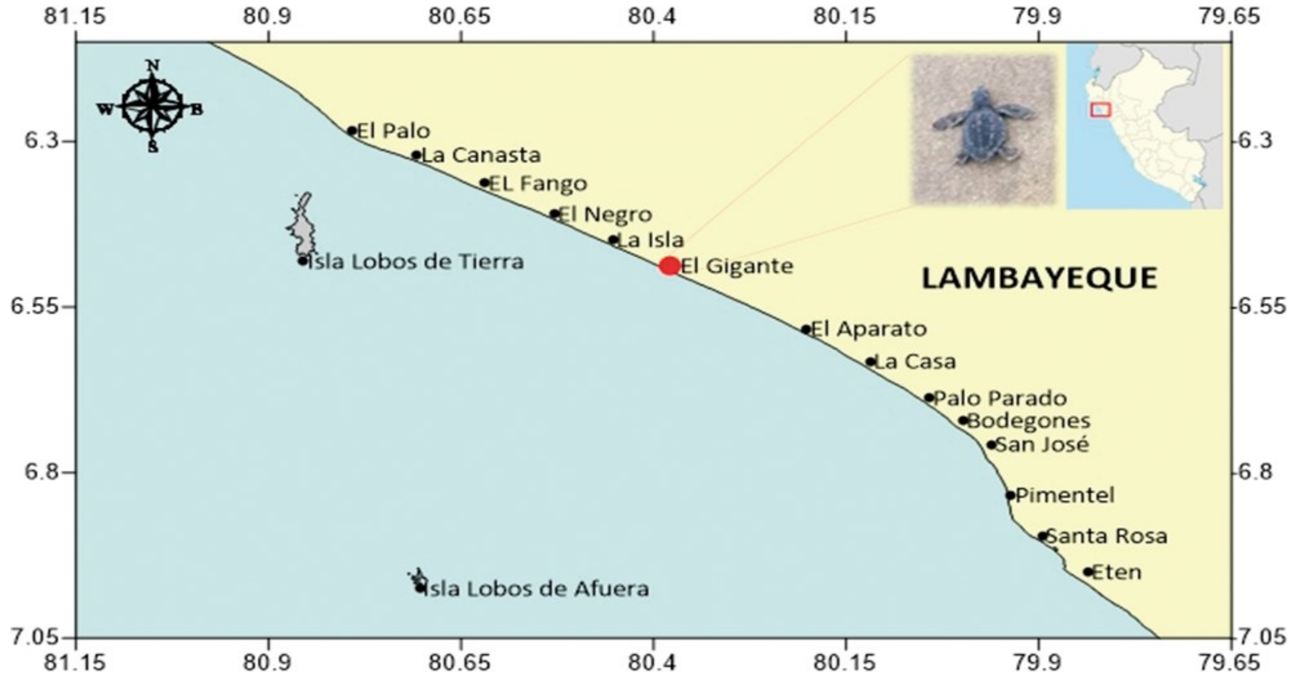

Figure 2. The southernmost area of the nesting record of *L. olivacea* in the Lambayequean coast, March 2019 (Sarmiento et al. 2021, Ref. 117).

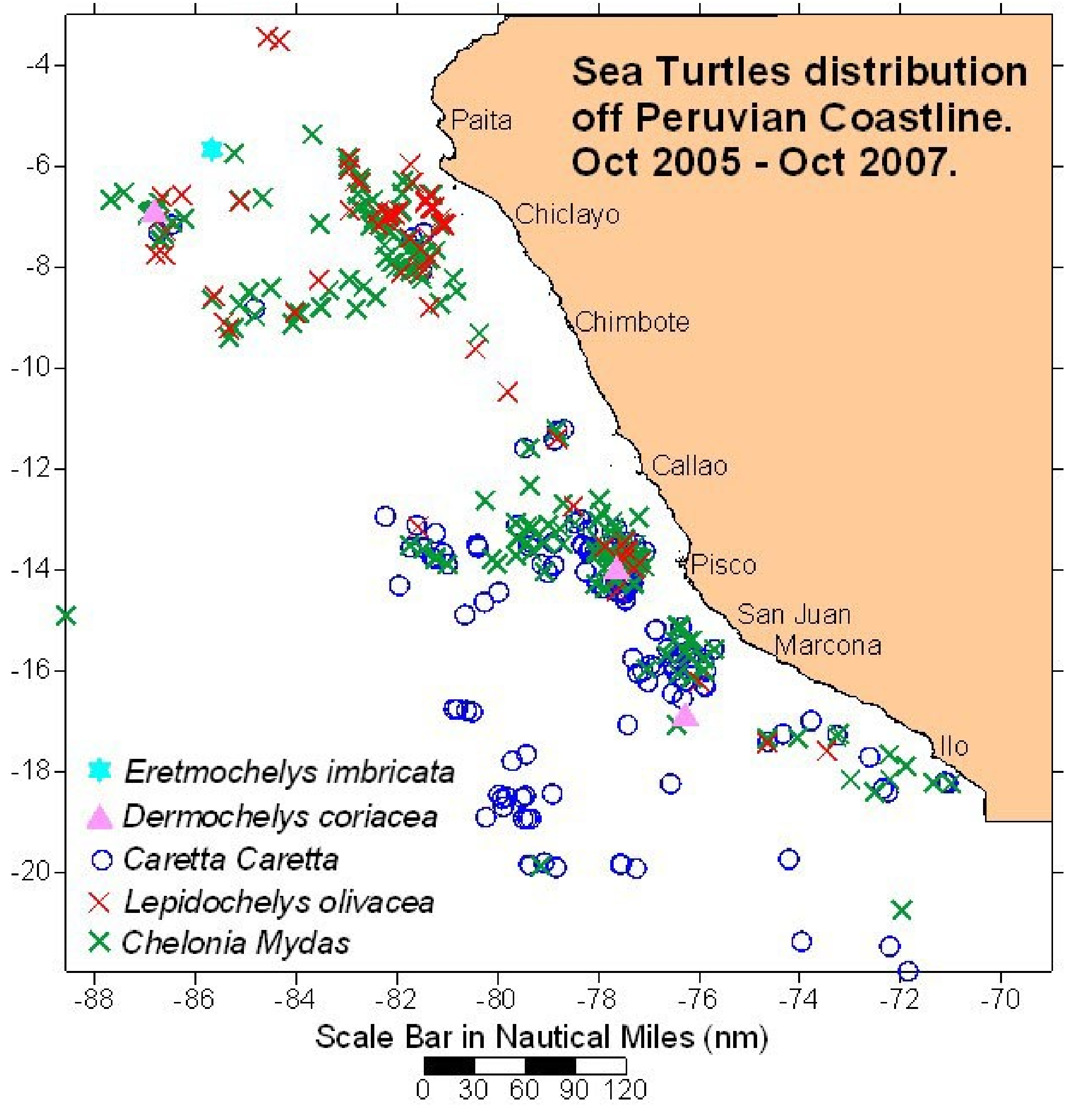

Figure 3. Sea turtle bycatch in pelagic longline off Peru. January 2005 - August 2007 (de Paz et al. 2010, Ref 66).

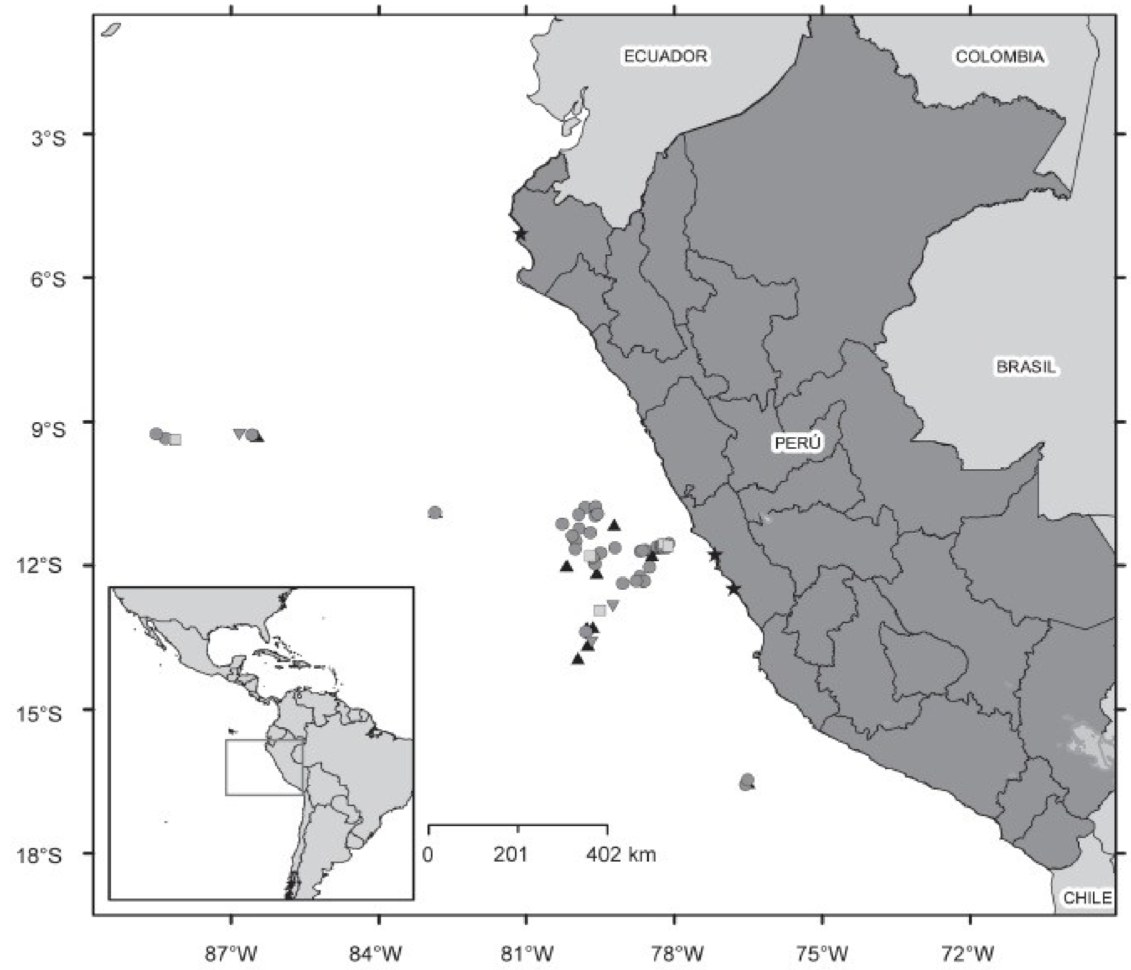

Figure 4. Sea turtle bycatch in pelagic longline off Peru. *Caretta caretta* (black triangles), *Chelonia mydas* (circles), *Lepidochelys olivacea* (squares), *Dermochelys coriacea* (inverted triangles). Sept 2009 - August 2010 (Ayala & Sanchez-Scaglioni 2010, Ref 69).

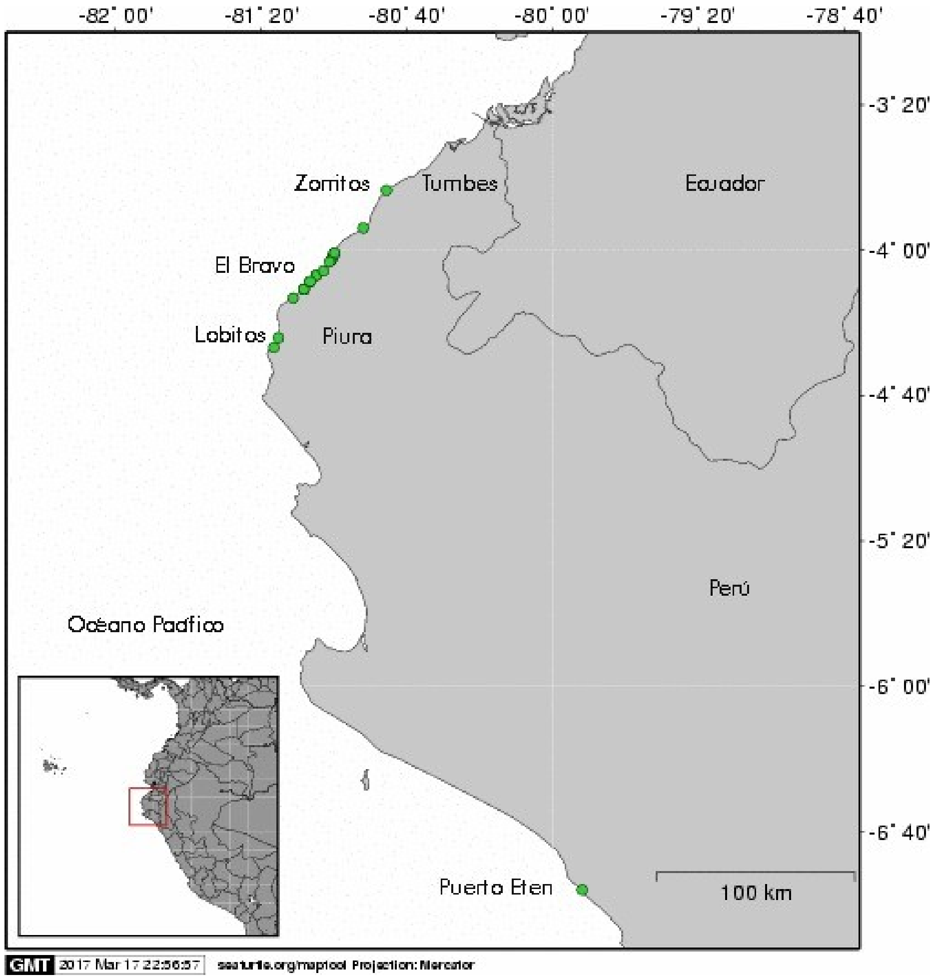

Figure 5. Places with confirmed nesting events of *Chelonia mydas* in northern beaches in Perú (ecOceanica, unpublished data).

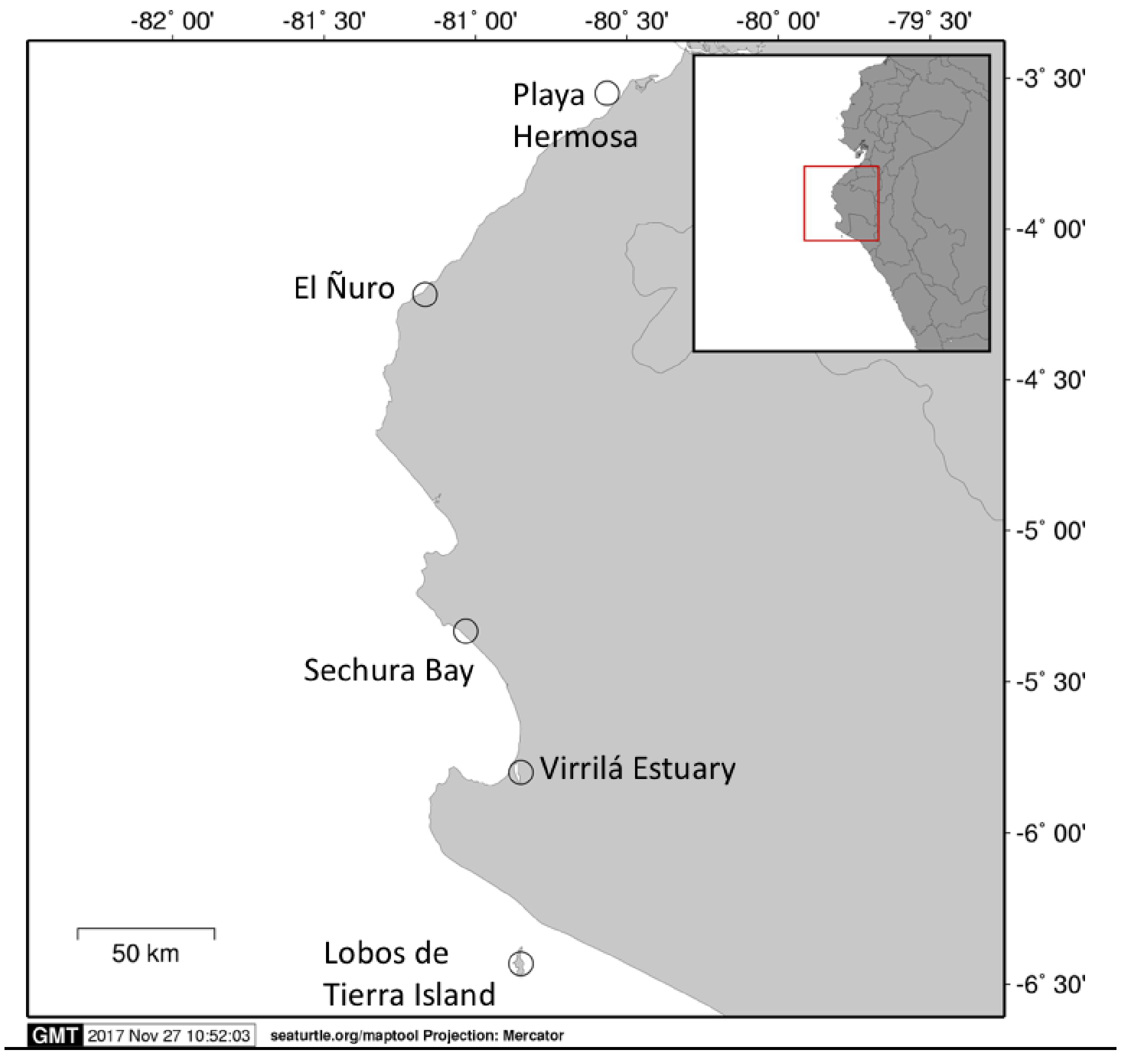

Figure 6. Principal foraging areas for *Chelonia mydas* identified in northern Perú (Ref 34, 37, 40, 57, N. de Paz pers. comm).

Chile

Álvarez-Varas, R. [1,2,3], Medrano, C.[2], Zárate, P.[4], Ortíz, J.C.[5], Sielfeld, W.[6], Salinas-Cisternas, P. [6], & Ulloa, M.[7]

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1. RMU: Green turtle (*Chelonia mydas*) – Pacific East

1.1. Distribution, abundance, trends

The green sea turtle populations in mainland Chile are part of the North-Central/Eastern Pacific Lineage (Figure 1). This lineage is also known as the black turtle; whose rookeries are restricted to the Eastern Pacific region (Álvarez-Varas et al. 2020c). It is known that Rapa Nui (Easter Island) hosts both Pacific genetic lineages: North-Central/Eastern Pacific Lineage (black turtle) and South-Central/Western Pacific Lineage (yellow turtle) (Álvarez-Varas et al. 2020b, 2021; Figure 1). No information exists about genetic lineages present in other Chilean oceanic islands.

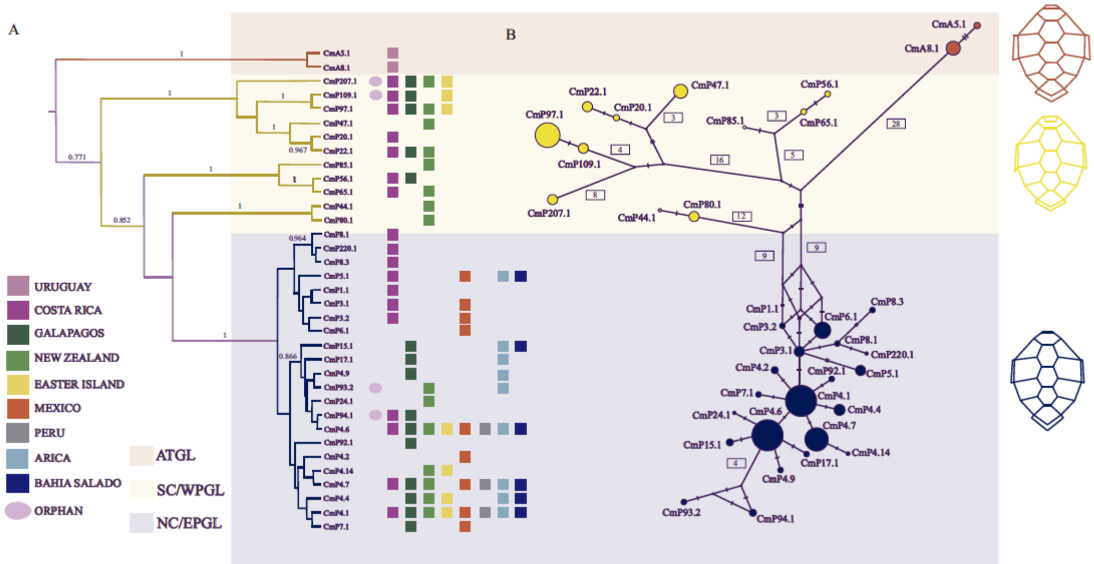

Figure 1. Phylogeographic analyses of *Chelonia mydas* control region haplotypes from Pacific and south-western Atlantic Oceans. ATGL, Atlantic genetic lineage; SC/WPGL, south-central/western Pacific genetic lineage; NC/EPGL, north-central/eastern Pacific genetic lineage. Figure extracted from Álvarez-Varas et al. 2020b.

1.1.1. Nesting sites

There are nor nesting sites in Chile.

1.1.2. Marine areas

The higher abundance of green turtles is concentrated in northern Chile, where individuals aggregate to feed. Six foraging grounds have been identified in the mainland territory from Arica to Atacama Region (Figure 2). In insular Chile, Rapa Nui (Easter Island) represents an important feeding ground for this species hosting turtles throughout the year (Figure 3). In the Juan Fernandez Archipelago, it is also frequent to sight green turtles (Paulina Stowhas *pers.comm.*).

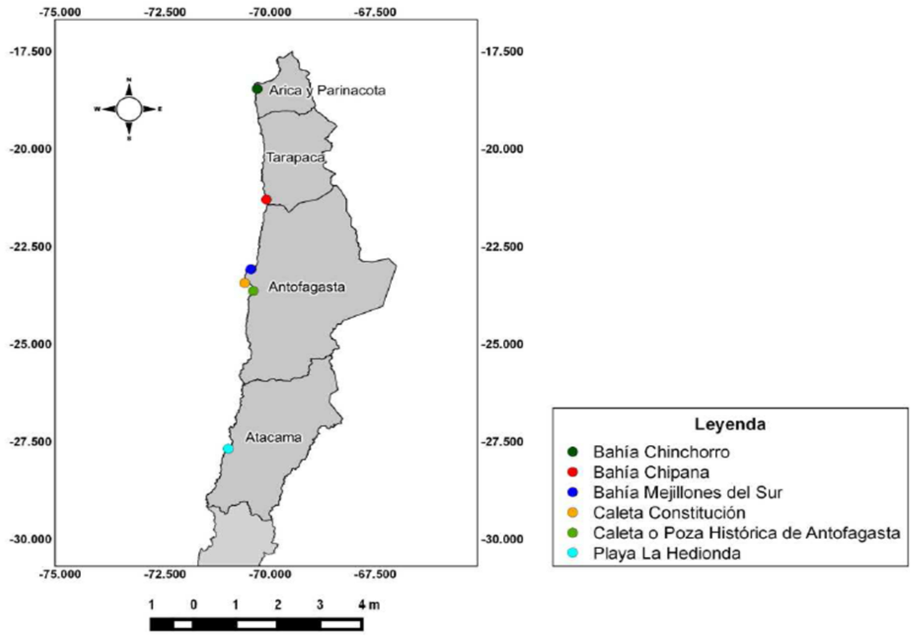

Figure 2. Foraging grounds of *Chelonia mydas* identified in mainland Chile. Image extracted from Álvarez-Varas et al. (2020c).

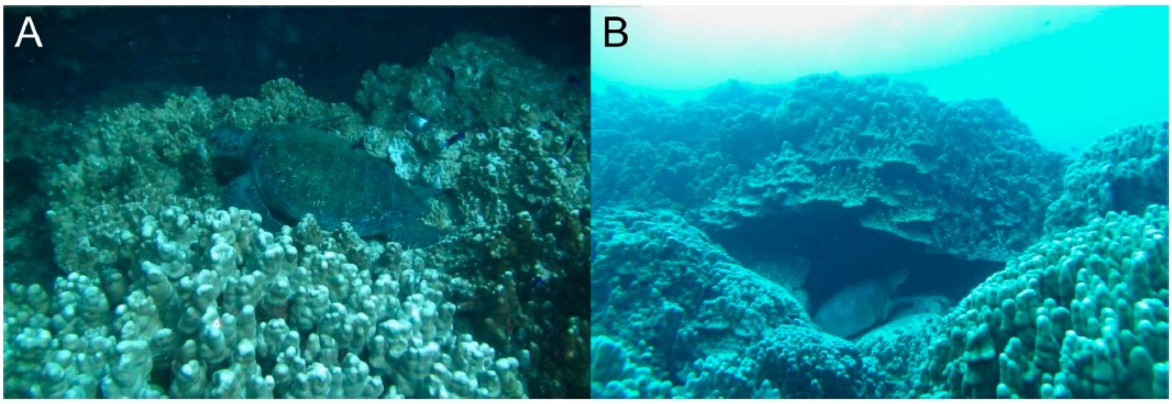

Figure 3. Green turtles resting on a coral flat at Papa Haoa reef (A) and in a cave in Manavai reef (B), Rapa Nui. Image extracted from Petit et al. (2020).

1.2. Other biological data

Sielfeld et al. (2019) suggested the green turtle population in La Puntilla, Arica Bay (Arica and Parinacota Region) comprise around 500 individuals, being the most important feeding congregation of this species in Chile. Turtles ranged from 44.6 to 98.6 cm straight carapace length (SCL), a mean body condition index of 1.64 (range 0.34–3.63), with mean annual growth rates of 4.6 cm/year (SD 2.97) (Sielfeld et al. 2019). In

2017 massive strandings occurred, probably related to anthropogenic causes and sea lion attacks. Since then, turtles seem to be no longer so frequent in this bay (Caleb Jara and Alfredo Álvarez *pers. comm*). In the case of Antofagasta (Antofagasta Region), since sea lion attack events in 2007, it is not common to see sea turtles close to the shore either (Ricardo Sarmiento *pers. comm*). It is probable that turtles in these areas are in deeper waters, as observed in some localities in the Antofagasta Region (Ricardo Sarmiento *pers. comm.*). Further monitoring will be needed to verify these aggregation`s status.

Studies carried out by Qarapara NGO showed that Bahia Salado (Atacama Region) hosts a small and healthy green turtle aggregation of around 20 resident juveniles. New recruitments have been reported during the last years, with turtles reaching about 37.5-40 cm of CCL. Also, high recapture rates have been confirmed for this aggregation with individuals recaptured up to 12 times between 2013 and 2021 (Carol Medrano *pers. comm*). Although a study published in 2017 showed elevated blood heavy metals in theses turtles (Álvarez-Varas et al. 2017), recent haematological and biochemical analyses confirm a good health status for this aggregation. Currently, new studies monitoring metals and green turtle feeding ecology are being carried out (Carol Medrano *pers. comm*).

Green turtles from Rapa Nui have mixed origins from different Pacific nesting rookeries (Álvarez-Varas et al. 2020b). A first monitoring in 2018 showed this location hosted juvenile and adult turtles ranging from 49 cm to 99 cm straight carapace length (SCL) and weighing between 15 kg and 138 kg (Moe Varua, 2018). Almost 50% of the aggregation exhibited carapace lesions and fractures, probably associated with boat collisions. Although all turtles showed good body condition and absence of epibionts, two of them exhibited skin lesions in head and flippers, probably associated with marine pollution and high-water temperature. Furthermore, one individual showed carapace deformity likely related to malnutrition, and another turtle had lost the vision of the left eye as a result of a fishhook (Moe Varua, 2018; Figure 4).

Figure 4. Green turtle with a left eye lesion associated with a fishhook. Photographer: Rocío Álvarez Varas

A recent IFOP report indicated that 50 turtles were incidentally caught in Chilean fishery vessels during 2019, 31 of them were green turtles whose curve carapace length (CCL) ranged between 41 cm and 67 cm, curve carapace width (CCW) between 45 cm and 67 cm, and total tail length (TTL) between 7 cm and 18 cm (Zárate et al. 2020). From these individuals, 16 showed internal hooking and 15 exhibited external hooking in flippers, shoulders, armpits, pelvis and tail (Zárate et al. 2020).

There are no updated data on the other foraging sites described for *C. mydas* in Chile. For more details, please see Álvarez-Varas et al. 2020c.

1.3. Threats

1.3.1. Nesting sites

There are no nesting sites in Chile.

1.3.2. Marine areas

Given de presence of green turtle aggregations in coastal areas, it is reported this species exhibits the highest bycatch rates by Chilean fisheries in the north of the country (Zárate et al. 2017, 2018, 2019). According to a recent IFOP report thirty-one green turtles were associated to bycatch during 2019. Nevertheless, estimations based on means and ratios revealed that 712 to 1,027 green turtles would have been bycaught during this year by the Chilean fishing fleet (Zárate et al. 2020).

Green turtle bycatch during 2019 was associated with the artisanal longline operating on sharks (EAT; Figure 5) and the artisanal longline operating on mahi-mahi (*Coryphaena Hippurus*; EAD; Figure 6). Captures were reported during the spring and summer months with water temperatures between 23-24°C in summer and 21°C in spring. In both cases, captures were informed northwards 21°S latitude with chlorophyl concentrations between 0.5 to 1 mg/m3. EAT was associated with high fishing efforts (27,700-70,200 hooks; Figure 5) and EAD was related to medium to high fishing efforts (3,300-79,100 hooks; Figure 6). Captures related to high water temperature and low-depth are consistent with historical green turtle bycatch reports (Zárate et al. 2020).

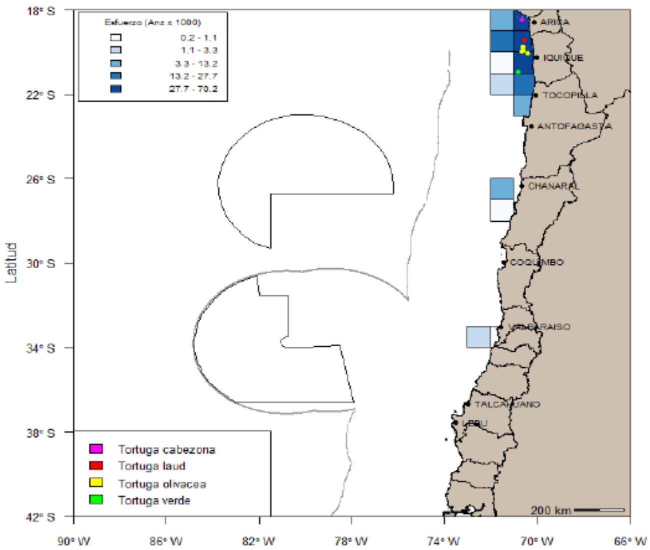

Figure 5. Spatial distribution of interaction between sea turtles (loggerhead, leatherback, olive ridley and green turtles: pink, red, yellow and green, respectively) and artisanal longline ("Espinel" in Spanish) fleet effort (hooks set), which operated on sharks (EAT) during 2019 (Zárate et al. 2020).

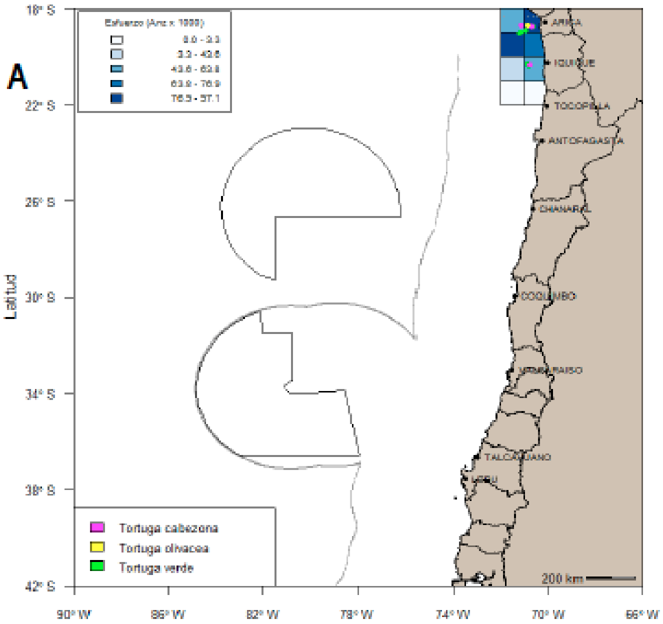

Figure 6. Spatial distribution of interaction between sea turtles (loggerhead, olive ridley and green turtles: pink, yellow and green, respectively) and artisanal longline ("Espinel" in Spanish) fleet effort (hooks set), which operated on mahi mahi (*Coryphaena Hippurus*; EAD) during 2019 (Zárate et al. 2020).

Foraging habitat degradation associated with coastal development and marine pollution has been an important threat to *C. mydas* population, both in mainland and insular Chile (see Álvarez-Varas et al. 2020c). Plastic pollution is an important threat for green turtles including Rapa Nui (Easter Island) due to the influence of the South Pacific subtropical Gyre (Figure 7). Thiel et al. (2018) describe the most frequent items found in the digestive system and feces of green turtles and other sea turtle species from the Chilean coast.

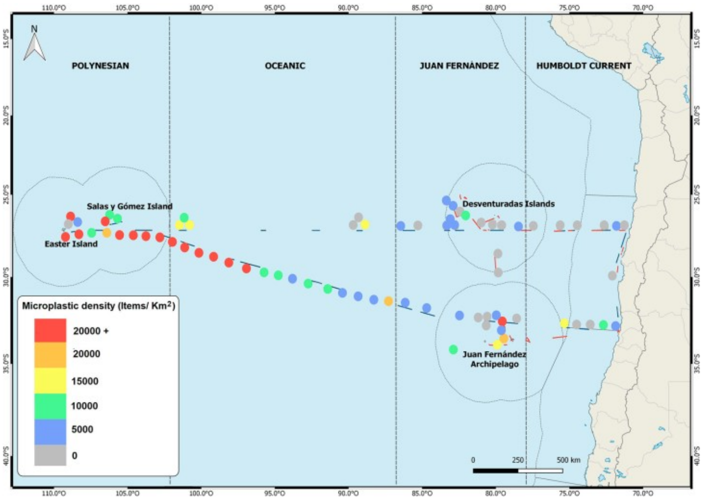

Figure 7. Density of microplastics (0.3–5mm) in the central South-eastern Pacific in 2015 and 2016. Figure retrieved from Thiel et al. (2018).

Boat strikes have been reported in Rapa Nui, especially in fishing coves where turtles feed (Álvarez-Varas et al. 2015b, 2020c; Figure 8). Sea lion attacks have been reported as a mortality cause for green turtles in Antofagasta and Arica in 2007 and 2017 respectively (Guerra-Correa et al. 2007a, 2008b, 2017a; Sielfeld et al. 2017a). Energy megaprojects constitute a potential threat for green turtle coastal populations, particularly in Bahia Salado where a multipurpose port to be built is being evaluated (see Álvarez-Varas et al. 2020c for more details).

Figure 8. Green turtle with carapace fracture as a result of a boat collision in Rapa Nui. Photographer: Rocío Álvarez Varas

During 2020, a total of 28 individuals were found stranded in the Chilean coast; six of them were *C. mydas*. Two specimens were rehabilitated at the Safari Park (Rancagua, O'Higgins Region; Figure 9), transferred and reintroduced in waters of the Atacama Region, northern Chile. Another individual was found stranded in the Rapa Nui coast; then stabilized and released *in situ*. The rest of the individuals were found dead (SERNAPESCA 2021). All turtles exhibited poor physical condition, severe dehydration, malnutrition, and immunosuppression.

Figure 9. Green turtle rehabilitated at the Safari Park (Rancagua, O'Higgins Region), Chile.

1.4. Conservation

Chelonia mydas is catalogued as Endangered by the Chilean normative (RCE 2015; Chilean Ministry of Environment, MMA). Currently, there are three programs focused on the conservation of this species in Chile, which entail monitoring, education and outreach activities (see Álvarez-Varas et al. 2020c for more details) As a consequence of covid-19, most activities related to these programs have been restricted. Likewise, the proposals to create marine protected areas focused on *Chelonia mydas* in La Puntilla (Arica and Parinacota Region) and in Bahia Salado (Atacama Region) have not showed progress during 2020-2021.

1.5. Research

Genetic studies carried out in mainland Chile indicate this species has its natal origin mainly in rookeries from the Galapagos Archipelago (Eastern Pacific region) and Mexico in a lesser extent (Álvarez-Varas et al. 2020c; Zárate et al. 2020). In contrast, Rapa Nui hosts individuals with multiple natal origins including Eastern Pacific, and South-central and Western Pacific rookeries (see Álvarez-Varas et al. 2020c).

Stable isotopes research covering more than 10,000 km of the American Pacific coast showed that green turtles from northern Chile (Mejillones, Antofagasta Region) had the highest bulk skin mean δ15N value among all green turtle populations south of the equator, which is probably related to the upwelling coastal system (Seminoff et al. 2021). This study also confirms the Eastern Pacific green turtles (or black turtles) consume larger amounts of invertebrates and they have greater prey diversity than their counterparts elsewhere (Seminoff et al. 2021).

Likewise, a recently published study suggested the evolutionary distinctiveness of the black turtle populations and adaptation signatures in its genome using more than 9,000 SNPs (Álvarez-Varas et al. 2021). Genes and enriched biological functions linked to thermoregulation, hypoxia, melanism, morphogenesis, osmoregulation, diet and reproduction were found to be outliers for differentiation between both Pacific genetic lineages (black and yellow turtles) (Álvarez-Varas et al. 2021; Figure 10). All these results point to address management conservation of black and yellow turtles separately, especially in foraging grounds where they are sympatrically (e.g. Rapa Nui).

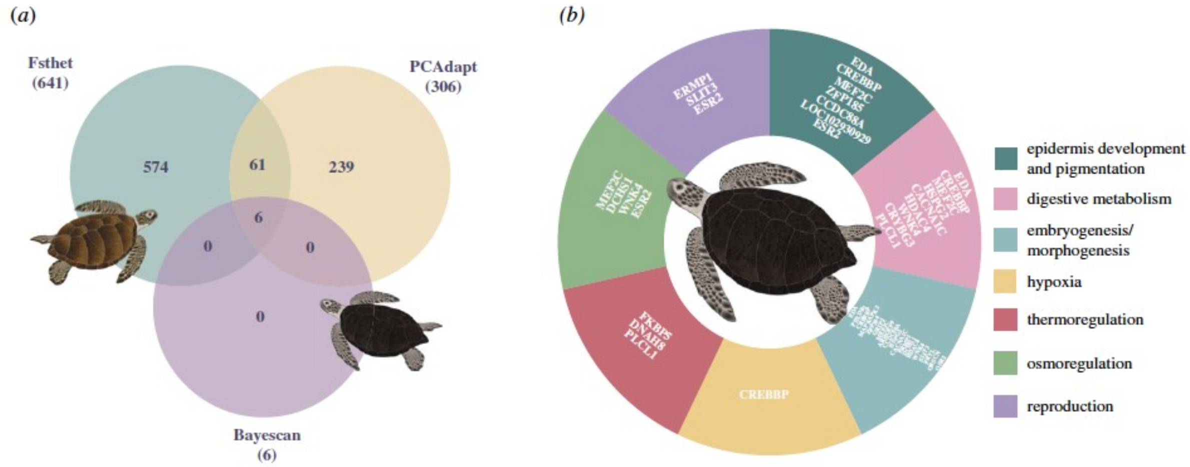

Figure 10. Outlier SNPs recovered among *Chelonia mydas* Pacific shape-based morphotypes (yellow and black turtle). (a) Venn diagram of loci under selection detected by three approaches, and (b) genes associated with putative main categories based on the descriptions related to each of the GO terms. Figure extracted from Álvarez-Varas et al. 2021.

2. RMU: Hawksbill turtle (*Eretmochelys imbricata*) – Pacific East

2.1. Distribution, abundance, trends

In the Eastern Pacific region, the hawksbill turtle is distributed between Mexico to Peru (see details in Álvarez-Varas et al. 2020c).

2.1.1. Nesting sites

There are no nesting sites in Chile.

2.1.2. Marine areas

Hawksbill turtle has been recently described in Rapa Nui (Easter Island; Figure 11), a Chilean oceanic island. Its natal origin remains unknown (Álvarez-Varas et al. 2020c). There are no more reports of this species in the rest of the country.

Figure 11. Individual of *Eretmochelys imbricata* swimming in coral reef 200 m west of Hanga Roa bay, Rapa Nui (Easter Island). Image extracted from Álvarez-Varas et al. 2015a.

2.2. Other biological data

There is no available data regarding this species in Chile during 2020.

2.3. Threats

2.3.1. Nesting sites

There are no nesting sites in Chile.

2.3.2. Marine areas

Marine pollution could be a significant threat for hawksbill turtles considering its benthic behavior associated with coral reefs, and the negative impact of garbage accumulation in the South Pacific Subtropical Gyre affecting Rapa Nui (Figure 8; see Álvarez-Varas et al. 2020c).

2.4. Conservation

This species has been classified as Critically Endangered by the Chilean normative (D.S. Nº 06, 2017; MMA). No data exist on fisheries affecting this species in Chilean waters.

2.5. Research

There are no published studies focused on *E. imbricata* in Chile. Ecological research and local waste management are crucial to protect hawksbill turtle populations and habitat in Rapa Nui (Álvarez-Varas et al. 2020c).

3. RMU: Leatherback turtle (*Dermochelys coriacea*) – Pacific East

3.1. Distribution, abundance, trends

The leatherback Chilean populations correspond to the Eastern Pacific subpopulation or Regional Management Unit (Álvarez-Varas et al. 2020c).

3.1.1. Nesting sites

There are no nesting sites in Chile.

3.1.2. Marine areas

A great part of records in Chile come from bycatch (see details in Álvarez-Varas et al. 2020c).

3.2. Other biological data

Genetic studies show the Chilean population has its origin mainly in the Eastern Pacific region. However, there also is evidence suggesting a natal origin from the Western Pacific (Álvarez-Varas et al. 2020c). Telemetry data confirm leatherback migration from Costa Rican nesting beaches towards Chilean waters (Shillinger et al. 2008; Zárate et al. 2020).

IFOP (Instituto de Fomento Pesquero) has collected samples from turtles and stomach contents for stable isotope analysis; however, the results still have not been analyzed due to the covid-19 contingency (Zárate et al. 2020).

3.3. Threats

3.3.1. Nesting sites

There are no nesting sites in Chile.

3.3.2. Marine areas

Historically, the leatherback turtle is the species with the highest number of individuals incidentally caught mainly by industrial longline; however, during 2019 only one specimen was reported as bycatch of artisanal longline operating on sharks (EAT, Espinel Artesanal in Spanish) (Figure 5). This capture was reported during winter in northern Chile (19.5ºS), water temperature of 17ºC and chlorophyl concentration around 1 mg/m3. Estimations based on means and ratios carried out by IFOP (including number of fishing trips with associated bycatch, number of individuals bycaught, among others) revealed that between 16 to 41 leatherbacks would have been bycaught during 2019 by the Chilean fishing fleet associated with highly migratory resources (Zárate et al. 2020).

Figure 12. Leatherback turtle entangled in a gillnet. IFOP photographs archive.

Marine pollution has also been identified as an important threat for this species. Some cases of plastic ingestion have been reported in leatherbacks from central Chile with major items comprising plastic fragments and plastic bags (Brito 2001; Thiel et al. 2018; see details in Álvarez-Varas et al. 2020c).

3.4. Conservation

Dermochelys coriacea is classified as a Critically Endangered species in Chile. Currently, IFOP is evaluating mitigation actions for bycatch associated with gillnets and longline targeting mahi-mahi (*Coryphaena Hippurus*) (Álvarez-Varas et al. 2020c).

3.5. Research

Genetic and trophic ecology studies are still ongoing aiming to characterize the natal origin and trophic level of leatherbacks recovered from the national fishing fleet. Studies include the assessment of the trophic chain and the role of leatherbacks in it (Álvarez-Varas et al. 2020c).

4. RMU: Olive ridley turtle (*Lepidochelys olivacea*) – Pacific East

4.1. Distribution, abundance, trends

Chilean populations would correspond to the Eastern Pacific subpopulation (see Álvarez-Varas et al. 2020c).

4.1.1. Nesting sites

There are no nesting sites in Chile.

4.1.2. Marine areas

In Chile, this species is common to observe in oceanic and neritic areas, especially in northern and central Chile (see Álvarez-Varas et al. 2020c).

4.2. Other biological data

According to IFOP, thirteen Olive Ridley turtles were incidentally captured by Chilean vessels during 2019 and three of them were tagged (Zárate et al. 2020). The CCL of these turtles ranged between 63 cm and 70 cm, CCW between 58 cm and 88 cm and the TTL between 11 cm and 18 cm. Most of the turtles exhibited external hooking in flippers, shoulders and armpit, while only one individual was found entangled in a net.

4.3. Threats

4.3.1. Nesting sites

There are no nesting sites in Chile.

4.3.2. Marine areas

Olive ridley bycatch during 2019 was associated with the artisanal longline operating on sharks (EAT; Figure 5), the artisanal longline operating on mahi-mahi (*Coryphaena Hippurus*; EAD; Figure 6) and the artisanal gillnet operating on swordfish (*Xiphias gladius*; RA; Figure 13). Captures of olive ridley turtles were reported in summer and winter months with water temperatures of 24ºC and 16ºC, respectively. In both cases, captures were informed northwards 22ºS latitude with chlorophyl concentrations between 0,5 and 1 mg/m3. RA reported the capture of one individual of olive ridley turtle during 2019 (Figure 13). Bycatch related to this fleet was informed between 21ºS and 22ºS latitude. This capture was associated with high fishing efforts (262-1.299 sets) (Figure 13). The estimations based on mean and ratios indicated that 234 to 522 olive ridley turtles would have been caught by Chilean fisheries in 2019 and 9.6% of them would have died as a result of bycatch (Zárate et al. 2020).

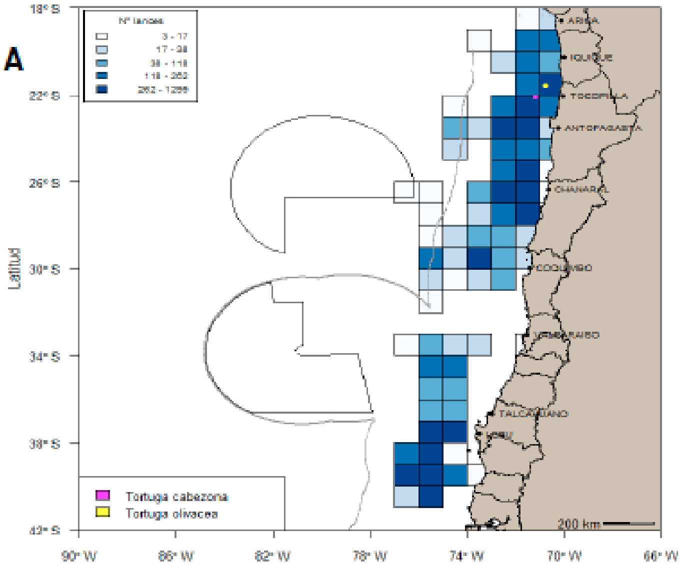

Figure 13. Spatial distribution of interaction between sea turtles (loggerhead and olive ridley: pink and yellow, respectively) and artisanal gillnet fleet effort which operated on swordfish (RA) during 2019 (Zárate et al. 2020).

Plastic pollution has also been identified as a significant threat for olive ridley turtles in Chilean waters. The first and unique case so far of fibropapillomatosis in Chile was reported in an olive ridley turtle in 2019 (see details in Álvarez-Varas et al. 2020c; Figure 14).

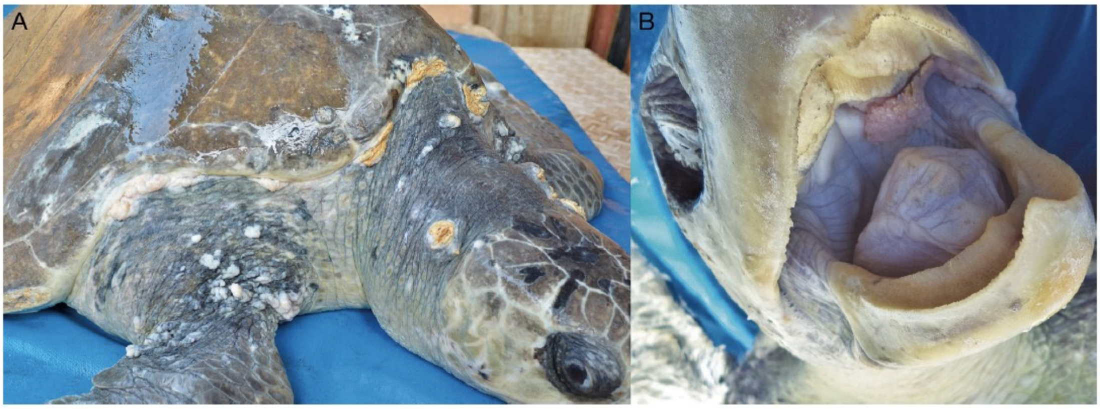

Figure 14. Fig. 1. Cutaneous lesions on neck and anterior flippers and inside the oral cavity of an olive ridley turtle *Lepidochelys olivacea* rehabilitated at Fundación Mundomar, Chile. Image extracted from Álvarez-Varas et al. (2019).

From the total of stranded sea turtles along the Chilean coast (n=28), 22 corresponded to olive ridley turtles. Two of them were rehabilitated at the Rescue Center of the Antofagasta University (Antofagasta Region, northern Chile) and successfully released in the same region (SERNAPESCA, 2020).

4.4. Conservation

Lepidochelys olivacea is classified as a Vulnerable species in Chile (D.S. Nº 06, 2017; MMA). Currently, IFOP is evaluating different types of fisheries affecting olive ridley populations to propose and promote mitigation measures at a national level.

4.5. Research

An IFOP report informed that olive ridley turtles from Chilean foraging grounds come from different nesting sites located in the South-western Pacific and North-eastern Pacific. However, given the small sample size, it was not possible to determine the specific contribution of each natal beach (Zárate et al. 2020). Genetic and trophic ecology studies are still ongoing aimed to characterize the natal origin and trophic level of turtles recovered from the national fishing fleet (Zárate et al. 2020).

5. RMU: Loggerhead turtle (*Caretta caretta*) – Pacific East

5.1. Distribution, abundance, trends

Chilean populations would be part of the South Pacific subpopulation, which breeds in eastern Australia and New Caledonia (see details in Álvarez-Varas et al. 2020c).

5.1.1. Nesting sites

There are no nesting sites in Chile.

5.1.2. Marine areas

A great part of records in Chile come from bycatch (see details in Álvarez-Varas et al. 2020c). This species is more frequent in the north of Chile (Zárate et al. 2020).

5.2. Other biological data

A recent IFOP report informed that five loggerhead turtles were incidentally captured by Chilean vessels during 2019. Nevertheless, estimations based on mean and ratios indicated that between 128 and 175 loggerheads would have been captured during this year considering the entire Chilean fleet that have interaction with this species in the country. The 28.6% of these turtles would have died as a consequence of bycatch (Zárate et al. 2020).

Of these 5 turtles, three were tagged; the CCL was between 57 cm and 68 cm, the CCW between 55 cm and 67 cm and TTL between 9 cm and 12 cm. Two individuals exhibited external hooking in flippers, one specimen showed internal hooking in the oral cavity and other two were found entangled in fishing gear (Zárate et al. 2020).

5.3. Threats

5.3.1. Nesting sites

There are no nesting sites in Chile.

5.3.2. Marine areas

Historically, loggerhead turtles have been captured by all Chilean fleets associated with highly migratory resources. During 2019, loggerhead captures (n=5) were reported during summer and winter in northern Chile, between 19º and 22ºS. In summer, captures were associated with water temperatures of 24ºC and in winter with temperatures between 16º and 17ºC. In both cases, the chlorophyll concentration ranged between 0.5 mg and 1 mg/m3. These captures were linked to the three fleets operating in warm waters of Chile (EAT, EAD and RA; Figure 5, 6 and 13 respectively).

Figure 15. Loggerhead turtle captured in the longline fleet. IFOP photographs archive.

5.4. Conservation

This species has been classified as Critically Endangered by the Chilean normative (D.S. Nº 06, 2017; MMA). Currently, IFOP is evaluating different types of fisheries affecting loggerhead populations to propose and promote mitigation measures at a national level.

5.5. Research

Genetic research carried out by IFOP indicates *C. caretta* individuals from Chile have haplotypes shared with Australia and New Caledonia (Zárate et al. 2018, 2019, 2020). Contrarily to other sea turtle species, there are just a few nesting areas of loggerheads in the Eastern Pacific region (Zárate et al. 2020).

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Table 1. Biological and conservation information about sea turtle Regional Management Units in Chile.

Species	*Chelonia mydas*		*Eretmochelys imbricata*		*Dermochelys coriacea*		*Lepidochelys olivacea*		*Caretta caretta*	
RMU	**Eastern Pacific**	**Ref #**	**Eastern Pacific**	**Ref #**	**Eastern Pacific**	**Ref #**	**Eastern Pacific**	**Ref #**	**Eastern Pacific**	**Ref #**
Occurrence										
Pelagic foraging grounds	Y	15, 16, 17, 18, 19, 20, 23, 24, 28, 37, 41, 42, 50, 60, 63, 64, 65, 66, 67, 74, 79, 83, 103, 104, 105, 108	N		Y	15, 16, 18, 19, 20, 24, 37, 41, 42, 50, 62, 63, 64, 65, 66, 67, 74, 79, 92, 103, 104, 105, 106, 107, 108	Y	15, 16, 18, 19, 24, 37, 41, 42, 50, 62, 63, 64, 65, 66, 67, 74, 79, 103, 104, 105, 106, 107, 108	Y	15, 16, 18, 19, 20, 24, 37, 40, 41, 42, 50, 63, 64, 65, 66, 67, 74, 79, 93, 103, 104, 105, 106, 107, 108
Benthic foraging grounds	Both	2, 4, 5, 6, 8, 10, 13, 21, 27, 29, 38, 39, 44, 52, 53, 54, 56, 58, 61, 63, 67, 70, 71, 75, 77, 78, 79, 83, 84, 86, 88, 101	Y	1, 2, 5, 8	Both	2, 29, 63, 67	Both	2, 13, 29, 63, 67	Both	2, 29, 63, 67
Published studies										
Growth rates	Y	83, 84	N		N		N		N	
Genetics	Y	4, 10, 12, 38, 39, 41, 42, 44, 46, 47, 79, 101, 103, 107, 108	N		Y	38, 41, 42, 79, 106, 107, 108	Y	38, 41, 42, 103, 106, 107, 108	Y	38, 40, 41, 42, 106, 107, 108
Stocks defined by genetic markers	Y	4, 10, 12, 38, 41, 44, 56, 79, 101	N		Y	38, 41, 47, 68, 106, 107, 108	Y	38, 106, 107, 108	Y	38, 41, 47, 106, 107, 108
Remote tracking (satellite or other)	Y	53, 63, 77, 78	N		N		N		N	

Survival rates	N		N	N		N		N	
Population dynamics	Y	75, 104	N	Y	104	Y	104	Y	104
Foraging ecology (diet or isotopes)	Y	32, 49, 61, 75, 81, 82, 88, 97, 103, 104, 106, 108	N	Y	79, 104, 106, 108	Y	51, 103, 104	Y	51, 80, 104, 106, 108
Capture-Mark-Recapture	Y	4, 53, 56, 63, 83, 84, 103, 106, 107, 108	N	Y	18, 24, 30, 103, 106, 107, 108	Y	24, 103, 106, 107, 108	Y	103, 106, 107, 108
Threats									
Bycatch: presence of small scale / artisanal fisheries	Y (PLL, SN,DN,OTH: SN(Purse seine))	2, 9, 24, 26, 29, 30, 74, 79, 108	N	Y (PLL, SN,DN,OTH: SN(Purse seine))	16, 18, 19, 20, 24, 29, 50, 63, 67, 79, 103, 104, 105, 106, 107, 108	Y (PLL, SN,DN,OTH: SN(Purse seine))	16, 18, 19, 20, 24, 50, 63, 67, 103, 104, 105, 106, 107, 108	Y (PLL, SN,DN,OTH: SN(Purse seine))	16, 18, 19, 20, 50, 63, 67, 103, 104, 105, 106, 107, 108
Bycatch: presence of industrial fisheries	Y (PLL, SN (Purse seine))	15, 16, 18, 19, 20, 24, 29, 40, 41, 42, 50, 63, 64, 65, 66, 67, 105, 107, 108	N	Y (PLL, SN (Purse seine))	15, 16, 18, 19, 20, 24, 29, 38, 40, 41, 42, 43, 50, 63, 64, 65, 66, 67, 99, 104, 105, 106, 107, 108	Y (PLL, SN (Purse seine))	15, 16, 18, 19, 20, 24, 40, 41, 42, 63, 64, 65, 66, 67, 105, 106, 107, 108	Y (PLL, SN (Purse seine))	15, 16, 18, 19, 20, 24, 40, 41, 42, 50, 63, 64, 65, 66, 67, 105, 106, 107, 108
Bycatch: quantified	Y	15, 16, 18, 19, 20, 24, 41, 42, 50, 63, 64, 65, 66, 67, 103, 104, 105, 106, 107, 108	N	Y	15, 16, 18, 19, 20, 24, 41, 42, 50, 63, 64, 65, 66, 67, 103, 104, 105, 106, 107, 108	Y	15, 16, 18, 19, 20, 24, 41, 42, 50, 63, 64, 65, 66, 67, 103, 104, 105, 106, 107, 108	Y	15, 16, 18, 19, 20, 24, 41, 42, 63, 64, 65, 66, 67, 103, 104, 105, 106, 107, 108
Take. Intentional killing or exploitation of turtles	Y	2, 9, 24, 26, 29, 30, 37, 74, 79	N	N		Y	24, 26	Y	29, 37, 74
Coastal Development. Boat strikes	Y	8	N	Y	89	Y	24, 26, 89	N	

Pollution (debris, chemical)	Y	2, 4, 8, 13, 24, 26, 29, 55, 79, 89, 96	Y	1	Y	24, 89	Y	13, 26, 89	N	
Pathogens	N		N		N		Y	7	N	
Climate change	N		N		N		N		N	
Foraging habitat degradation	Y	2, 3, 4, 8, 14, 33, 100	y	1	Y	3	Y	3	Y	3
Depredation	Y	26, 29, 54, 56, 57, 58, 63, 79, 84, 85, 89	N		Y	69, 89	Y	26, 63, 89	Y	63
Epibionts	Y	24, 29, 48, 70, 85, 86	N		Y	24	Y	24, 25, 29, 48, 51, 72	Y	24
Debilitated Turtle Syndrome (DTS)/Buoyancy disorder	Y	48, 85, 89, 98	N		Y	89	Y	48, 59, 89	Y	48
Strandings	Y	3, 30, 54, 67, 73, 76, 79, 80	Y	1, 3, 80	Y	3, 67, 79, 80	Y	3, 67, 73, 79, 80	Y	3, 67, 79, 80
Long-term projects										
Monitoring at foraging sites	Y	2, 4, 5, 52, 53, 58, 63, 67, 77, 78, 83, 84, 101	N		Y	52, 67, 106, 107, 108	Y	52, 67	Y	67, 106, 107, 108
Conservation										
Protection under national law	Y	16, 22, 24, 29, 31, 34, 35, 63, 79, 83, 90, 91, 102, 106, 107, 108	Y	31, 36, 91, 94, 102, 104	Y	16, 22, 24, 29, 31, 34, 35, 63, 79, 91, 92, 102, 107, 108	Y	16, 22, 24, 29, 31, 34, 36, 63, 79, 91, 95, 102, 107, 108	Y	16, 22, 24, 29, 31, 34, 36, 63, 79, 91, 93, 102, 107, 108
Long-term conservation projects (number)	3	4, 29, 53, 61, 63, 77, 78, 83, 84, 85, 103, 104	N		1	29, 63, 103, 104	1	29, 103, 104	1	63, 103, 104
Head-starting	N		N		N		N		N	

By-catch: fishing gear modifications (eg, TED, circle hooks)	Y (PLL)	40, 41, 42, 104, 107, 108	Y	104	Y (PLL)	40, 41, 42, 45,68, 104, 107, 108	Y (PLL)	40, 41, 42, 104, 106, 107, 108	Y (PLL)	40, 41, 42, 104, 106, 107, 108
By-catch: onboard best practices	Y	15, 18, 19, 63, 104, 105, 107, 108	Y	104	Y	15, 18, 19, 63, 104, 105, 107, 108	Y	15, 18, 19, 63, 104, 105, 106, 107, 108	Y	15, 18, 19, 104, 105, 106, 107, 108
By-catch: spatio-temporal closures/reduction	N		N		N		N		N	
Research	Genetic studies carried out in mainland Chile indicate this species has its natal origin mainly in rookeries from the Galapagos Archipelago (Eastern Pacific region) and Mexico in a lesser extent (Álvarez-Varas et al. 2020c; Zárate et al. 2020). In contrast, Rapa Nui hosts individuals with multiple natal origins including Eastern Pacific, and South-central and Western Pacific rookeries (see Álvarez-Varas et al. 2020c).		There are no published studies focused on *E. imbricata* in Chile. Ecological research and local waste management are crucial to protect hawksbill turtle populations and habitat in Rapa Nui (Álvarez-Varas et al. 2020c).		Genetic and trophic ecology studies are still ongoing aiming to characterize the natal origin and trophic level of leatherbacks recovered from the national fishing fleet. Studies include the assessment of the trophic chain and the role of leatherbacks in it (Álvarez-Varas et al. 2020c).		An IFOP report informed that olive ridley turtles from Chilean foraging grounds come from different nesting sites located in the South-western Pacific and North-eastern Pacific. However, given the small sample size, it was not possible to determine the specific contribution of each natal beach (Zárate et al. 2020). Genetic and trophic ecology studies are still ongoing aimed to characterize the natal origin and trophic level of turtles recovered from the national fishing fleet (Zárate et al. 2020).		Genetic research carried out by IFOP indicates *C. caretta* individuals from Chile have haplotypes shared with Australia and New Caledonia (Zárate et al. 2018, 2019, 2020). Contrarily to other sea turtle species, there are just a few nesting areas of loggerheads in the Eastern Pacific region (Zárate et al. 2020).	
Conservation actions	Chelonia mydas is catalogued as Endangered by the Chilean normative (RCE 2015; Chilean Ministry of Environment, MMA). Currently, there are four programs focused on the conservation of this species in Chile, which entail monitoring, education and outreach activities (see Álvarez-Varas et al. 2020c for more details) As a consequence of covid-19, most activities related to these programs have been restricted. Likewise, the proposals to create marine protected areas focused on Chelonia mydas in La Puntilla (Arica and Parinacota Region) and in Bahia Salado (Atacama Region) have not showed progress during 2020-2021.		This species has been classified as Critically Endangered by the Chilean normative (D.S. Nº 06, 2017; MMA). No data exist on fisheries affecting this species in Chilean waters.		Dermochelys coriacea is classified as a Critically Endangered species in Chile. Currently, IFOP is evaluating mitigation actions for bycatch associated with gillnets and longline targeting mahi-mahi (Coryphaena Hippurus) (Álvarez-Varas et al. 2020c).		Lepidochelys olivacea is classified as a Vulnerable species in Chile (D.S. Nº 06, 2017; MMA). Currently, IFOP is evaluating different types of fisheries affecting olive ridley populations to propose and promote mitigation measures at a national level.		This species has been classified as Critically Endangered by the Chilean normative (D.S. Nº 06, 2017; MMA). Currently, IFOP is evaluating different types of fisheries affecting loggerhead populations to propose and promote mitigation measures at a national level.	

Table 2. International conventions protecting sea turtles and signed by Chile.

International Conventions	Signed	Binding	Compliance measured and reported	Species	Conservation actions	Relevance to sea turtles
Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC)	Y	Y	Y	CC, CM, DC, EI, LO	Prohibition of deliberate take of sea turtles or their eggs; compliance with the Convention on International Trade in Endangered Species (CITES); implemention of appropriate fishing practices and gear technology to reduce incidental take (bycatch) of turtles in all relevant fisheries; use of Turtle Excluder Devices (TEDs) on shrimp trawl vessels; designation of protected areas for critical turtle habitat; restriction of human activities that could harm turtles and promotion of sea turtle research and education	Binding commitment by Contracting Parties to implement domestic measures to reduce threats to sea turtles
Convention of International Trade of Endangered Species (CITES)	Y	Y	Y	CC, CM, DC, EI, LO	Sanction commerce and/or possession of such specimens; foresee seizure or return of such specimens to the exporting country	Regulation of International Trade
Convention on Biological Diversity (CBD)	Y	Y	Y	CC, CM, DC, EI, LO	Elaboration and execution of the National Strategy and Action Plan for biodiversity protection; Integration of sustainable use of biodiversity and conservation in plans, programs and sectorial or intersectorial policies.	Biodiversity and Environmental Protection
Convention on the Conservation of Migratory Species of Wild Animals (CMS)	Y	Y	Y	CC, CM, DC, EI, LO	Participant countries must: Promote, cooperate and collaborate in financing research on migratory species, allocate immediate protection to certain migratory species and establish agreements related to conservation and management of migratory species	Conservation of Migratory Species and their Habitats

South Pacific Permanent Comission (CPPS)	Y	Y	Y	CC, CM, DC, EI, LO	Coordinate regional maritime policies in order to adopt concerted positions of its Member States in international negotiations, development of the Law of the Sea, International Environmental Law and other multilateral initiatives. CPPS is engaged in a capacity-building process at the national and regional levels in the areas of science, socio-economic policy and the environment.	Marine Environmental Policies
Agreement for the Protection of the Marine Environment and the Coastal Zone of the Southeast Pacific	Y	Y		CC, CM, DC, EI, LO	Research and monitoring of marine contamination; environmental management (management of integrated coastal zones); assessment of the marine environment; administration of protected coastal and marine areas; conservation of marine mammals of the Southeast Pacific; research on marine and coastal biodiversity; studies and reports on climate change and dissemination of information and public awareness	Marine Protection
Protocol for the Conservation and Management of Marine and Coastal Protected Areas of the Southeast Pacific	Y	Y		CC, CM, DC, EI, LO	Establishement of protected marine areas for contracting parties	Marine Protected Areas
United Nations Convention on the Law of the Sea (UNCLOS)	Y	Y		CC, CM, DC, EI, LO	Promote the use of oceans and seas with peaceful purposes, and its resources fairly and efficiently. International Action Plan to prevent, stop and eliminate illegal, non-declared and non-regulated fishing in Chile.	Ilegal Fisheries; Protection of Marine Resources
Protocol for the Protection of the South-East Pacific against Radioactive Pollution	Y	Y		CC, CM, DC, EI, LO	Forbid all dumping of radioactive waste within the Chilean 200 nautical miles	Marine Protection

Agreement on Regional Cooperation in Combating Pollution of the South-East Pacific by Hydrocarbons or other Harmful Substances in cases of Emergency	Y	Y	CC, CM, DC, EI, LO	Regional Contingency Plan for Fossil Fuel Spills and Hazardous Substances; and Regional Contingency Plan for Oilspill and Emergency Response in the Southeast Pacific	Marine Protection
United Nations Framework Convention on Climate Change (UNFCCC)	Y	Y	CC, CM, DC, EI, LO	Overall framework for intergovernmental efforts to tackle the challenge posed by climate change.	Environmental Protection
Kyoto Protocol (UNFCCC)	Y	Y	CC, CM, DC, EI, LO	Internationally binding emission reduction targets	Environmental Protection

Table 3. Projects and databases on sea turtles in Chile.

Type	Intitution/organization	Area	Extension
Public	Ministerio de Medio Ambiente (MMA)	Species classification at national level through the Species Classification Regulation (Reglamento de Clasificación de Especies Silvestres, RCE, in Spanish)	National
	Grupo Nacional de Trabajo de Tortugas Marinas (GTTM)	Elaboration of the National Action Plan for the Protection and Conservation of Sea Turtles in Chile	National
	Subsecretaría de Pesca y Acuicultura (SUBPESCA)/Ministerio de Economía, Fomento y Turismo.	Regulation and management of fishing and aquaculture activities, through policies, rules and administrational measures, under a precautionary and systemic approach that promotes the conservation and sustainability of hydro-biological resources for the productive development of the area.	National
	Unidad de Rescate, Rehabilitación y Conservación de Especies Protegidas (URCEP)/Servicio Nacional de Pesca y Acuicultura (SERNAPESCA)	Sea turtle rescue and rehabilitation, strandings	National
	TORTUMAR/Universidad Arturo Prat	Ecological research, sea turtle monitoring and environmental education	Regional-Arica (northern Chile)
	Centro Regional de Estudios y Educación Ambiental (CREA)/Universidad de Antofagasta)	Ecological research, sea turtle monitoring, rescue and rehabilitation	Regional-Antofagasta (northern Chile)
Private	Instituto de Fomento Pesquero (IFOP)	Ecological and fisheries research, sea turtle monitoring and bycatch reduction	National
	Tortuga Verde NGO	Outreach, marine education	Regional-Arica (northern Chile)
	Qarapara Tortugas Marinas Chile NGO	Ecological research, monitoring, outreach, environmental education, rehabilitation and consulting	Regional-Atacama (northern Chile)