Sea Turtles in the East Pacific Ocean Region

IUCN-SSC Marine Turtle Specialist Group Annual Regional Report 2020

Editors

Juan M. Rguez-Baron, Shaleyla Kelez, Michael J. Liles, Alan Zavala-Norzagaray, Diego F. Amorocho, Alexander R. Gaos

Photo: Hawksbill sea turtle (RMU EI-EP) at Estero Padre Ramos, Nicaragua.

Photo credit: Alexander R. Gaos

Recommended citation for this report:
Rguez-Baron J.M., Kelez S., Lilies M.J., Zavala-Norzagaray A., Amorocho D., Gaos A. R. (Eds.) (2020). *Sea Turtles in the East Pacific Region: MTSG Annual Regional Report 2020*. Draft Report of the IUCN-SSC Marine Turtle Specialist Group, 2020.

Recommended citation for a chapter of this report:
AUTHORS (2020). CHAPTER-TITLE. In: Rguez-Baron J.M., Kelez S., Lilies M.J., Zavala-Norzagaray A., Amorocho D., Gaos A. R. (Eds.). *Sea Turtles in the East Pacific Region: MTSG Annual Regional Report 2020*. Draft Report of the IUCN-SSC Marine Turtle Specialist Group, 2020.

TABLE OF CONTENTS

REGIONAL OVERVIEW

Juan M. Rguez-Baron[1,2,8], Shaleyla Kelez[3,8], Michael J. Liles[4,8], Alan Zavala-Norzagaray[5,8], Diego F. Amorocho[6,8], Alexander R. Gaos[7,8]

[1]JUSTSEA Foundation, Colombia
[2]Department of Biology and Marine Biology, University of North Carolina Wilmington, U.S.A.
[3]EcOceanica, Perú
[4]Asociación ProCosta, El Salvador
[5]Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional, Unidad Sinaloa, México
[6]Centro de Investigación para el Manejo Ambiental y el Desarrollo, Colombia
[7]Marine Turtle Biology and Assessment Program. NOAA Pacific Islands Fisheries Science Center, U.S.A.
[8]IUCN-SSC Marine Turtle Specialist Group

Table 1. Overview of Eastern Pacific country chapters submitted.

Country	Country Abbreviation used in main table (Table 2)	Included in present report
Canada	CA	NO
U.S.A.	US	YES
Mexico	MX	YES
Guatemala	GT	NO
El Salvador	SV	YES
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 12 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 10 (83.3%) of the countries found in the EP, with Canada and Guatemala representing the two exceptions (Table 1). Each year we expect to continue to fill data gaps (e.g., add missing country chapters) and increase the level of detail included in each country chapter.

1. RMU: *Dermochelys coriacea*, East Pacific (DC-EP)

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: *Dermochelys coriacea*, West Pacific (DC-WP)

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: *Eretmochelys imbricata*, East Pacific (EI-EP)

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 1 summarizes the scientific studies conducted on hawksbills in the region.

4. RMU: *Chelonia mydas*, East Pacific (CM-EP)

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: *Lepidochelys olivacea*, East Pacific (LO-EP)

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 1.

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 1. summarizes the scientific studies conducted on olive ridleys in the region.

6. RMU: *Caretta caretta*, North Pacific (CC-NP)

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 1.

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: *Caretta caretta*, South Pacific (CC-SP)

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 2. key biological information for sea turtles RMUs in the East Pacific Ocean.

Country chapters: US-United States, MX-Mexico, SV-El Salvador, NI-Nicaragua, CR-Costa Rica, PA-Panama, CO-Colombia, EC-Ecuador, PE-Peru, 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	Y	SV, NI, MX, EC, PA	Y	PE,CO,CR, SV, N, MXI, EC, PA
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
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 - 2018)	CR, NI, EC	17 (2008 - 2018)	CR, NI, MX, EC	21399 (1998 - 2018)	PE,CO, CR, NI, MX, EC
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	197.7	CR, SV, NI, MX, EC	1109.83	PE, CR, SV, NI, MX, EC, PA
Nesting females / yr			6130.7	CR, MX, EC	34.8	CR	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 (yrs) (N)			3.4 (947)	CR, MX, EC	3.1	CR, MX	2.5 (73)	SV, MX, EC,PA	1.5	MX
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						

CHAPTER 1 U.S.A.

Updated 2020

Ashleigh Bandimere[1]

[1]Oceanic Society

1. RMU: *Caretta caretta* - North Pacific

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, 12, 23). 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) that nests in Japan and most commonly forages off of the coast of Mexico (1, 2, 3, 5, 10, 23). *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 (23, 25, 48). See Figure 1 for loggerhead observations within the SCB.

1.2 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 (25, 28, 34, 47, 48).

1.3 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 (13, 25, 41). This spatio/temporal closure has resulted in a decreased number of loggerhead fishery interactions in the SCB since the creation of the conservation area (13). 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 (48).

1.4 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 (48).

2. RMU: *Chelonia mydas* - East Pacific

2.1 Distribution, Abundance, Trends

2.1.1 Nesting Sites
Not applicable.

2.1.2 Marine Areas
Green turtles (*Chelonia mydas*) forage 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 are isolated foraging areas in California that are uniquely habitable for green turtles year-round due to warmer water caused by power plant emissions (17, 18, 21, 22, 39, 40, 46). 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 (17, 18, 22, 39, 40, 46). 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 (20, 37).

2.2 Threats
Because these two green turtle foraging populations aggregate off of highly developed coastal areas, pollutants and contamination have been identified as a major threat to their survival (5, 6, 35, 36, 39). 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 (6, 35, 36). Elevated quantities of polychlorinated biophenyls (PCBs), which are associated with neurotoxicity, were also found in green turtles foraging in the SDB (5).

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 (22, 39, 40).

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 (8, 22, 39, 40, 46). 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 (8, 22, 39, 40, 46).

2.3 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 (17, 18, 22). 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 (46).

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 (39, 40).

2.4 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 (17, 22, 39, 45).

3. RMU: *Dermochelys coriacea* – West Pacific

3.1 Distribution, Abundance, Trends

3.1.1 Nesting Beaches

Not applicable.

3.1.2 Marine Areas

Leatherback turtles forage along the Pacific coast of the U.S. (see Fig. 3), with a range spanning from California to Oregon (4, 7, 9, 11, 29). 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 (4, 7, 8, 38).

3.2 Threats

Recent evaluation has determined that the western Pacific leatherback population has declined by 5.6% in the past 1990 (48). 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 (14, 15, 16, 17, 19, 22, 34, 38, 43, 44, 47).

Other threats include coastal development, which has led to more waste and vessel transit in leatherback foraging habitat off of California (48), the ingestion of oil, present in California waters due to increased oil extraction activities (48), and climate change, which is causing shifts in leatherback phenology and changes to upwelling patterns necessary for leatherback food sources (48).

3.3 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 (13, 15, 16, 19, 41). Since this conservation area was implemented, the incidental capture of leatherbacks has decreased (14, 15, 16, 34). 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 (48).

3.4 Research

Current research is summarized in Table 1.

Table 1. Main biology and conservation aspects of sea turtles of the western U.S.A.

RMU:	CC (North Pacific)	ref #	CM (East Pacific)	ref #	DC (West Pacific)	ref #
Occurrence						
Nesting sites	N		N		N	
Pelagic foraging grounds	Y (J)	2, 12, 23	Y (J,A)	26, 40	Y	4
Benthic foraging grounds	Y (J)	2, 12, 23	N		Y	4
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	30
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)	46	Down 5.6% since 1990	48
Oldest documented abundance: nests/yr (range of years)	n/a		n/a		n/a	
Published studies						
Growth rates	N		Y	27	N	
Genetics	Y	10	Y	20	Y	38
Stocks defined by genetic markers	Y	10	Y	20	Y	38
Remote tracking (satellite or other)	Y	23, 25	Y	17, 27, 39, 40	Y	4, 7
Survival rates	N		Y	26	N	
Population dynamics	Y	25	Y	3, 20, 26	Y	
Foraging ecology (diet or isotopes)	Y	2	Y	3	Y	31
Capture-Mark-Recapture	N		Y	26, 27	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	25, 33, 38, 42, 47, 48	PLL	38	DN, PLL	14, 15, 16, 17, 22, 33, 34, 38, 43, 44, 47
Bycatch: quantified?	Y	25, 28, 34, 47, 48	n/a		Y	14, 15, 16, 34
Take. Intentional killing or exploitation of turtles	N		N		N	

Take. Egg poaching	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	22, 39, 40	Y	48
Egg predation	N		N		N	
Pollution (debris, chemical)	n/a		Y	5, 6, 35, 36, 39	Y	30, 48
Pathogens	n/a		n/a		n/a	
Climate change	Y	48	Y	39	Y	4, 48
Foraging habitat degradation	n/a		Y	8, 22, 39, 40, 46	Y	48
Other						
Long-term projects						
Monitoring at nesting sites	n/a		n/a		n/a	
Number of index nesting sites	n/a		n/a		n/a	
Monitoring at foraging sites	Y		Y		Y	
Conservation						
Protection under national law	Y	39	Y	39	Y	39
Number of protected nesting sites (habitat preservation)	n/a		n/a		n/a	
Number of Marine Areas with mitigation of threats	1	25	1	39, 40	1	13, 15, 16
Long-term conservation projects (number)			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)	N		N		N	
By-catch: onboard best practices	N		N		N	

By-catch: spatio-temporal closures/reduction	Y	13, 25, 41	N		Y	13, 15, 16, 41
Other						

Table 2. Sea turtle nesting beaches of the Pacific U.S.A.

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)**
CC-NW IND				Long	Lat	Long	Lat	Long	Lat					
No nesting beaches	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 3. International conventions that affect sea turtles in the western 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

Table 4. Organizations and agencies related with sea turtle research and conservation in the western U.S.A.

Organization Name	**Organization Type**	**Location**	**Long-term (>5 consecutive years)**
National Oceanographic and Atmospheric Administration (NOAA) Fisheries	Governmental	National USA	Y

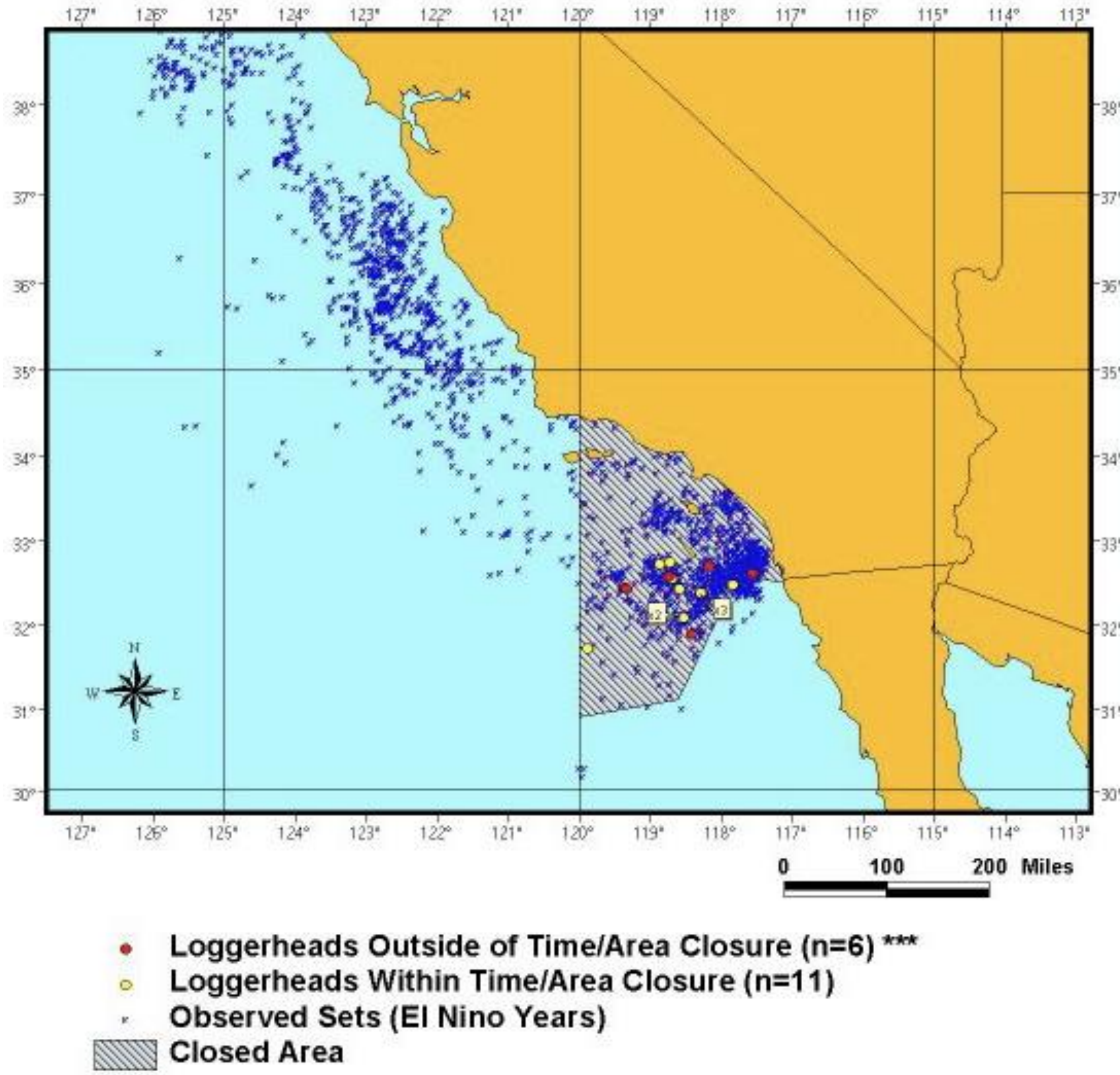


Figure 1. Loggerhead observations (red and yellow dots) within the SCB, and the area that closes to the CDGN during ENSO events (Eguchi, 2015, Ref 23).

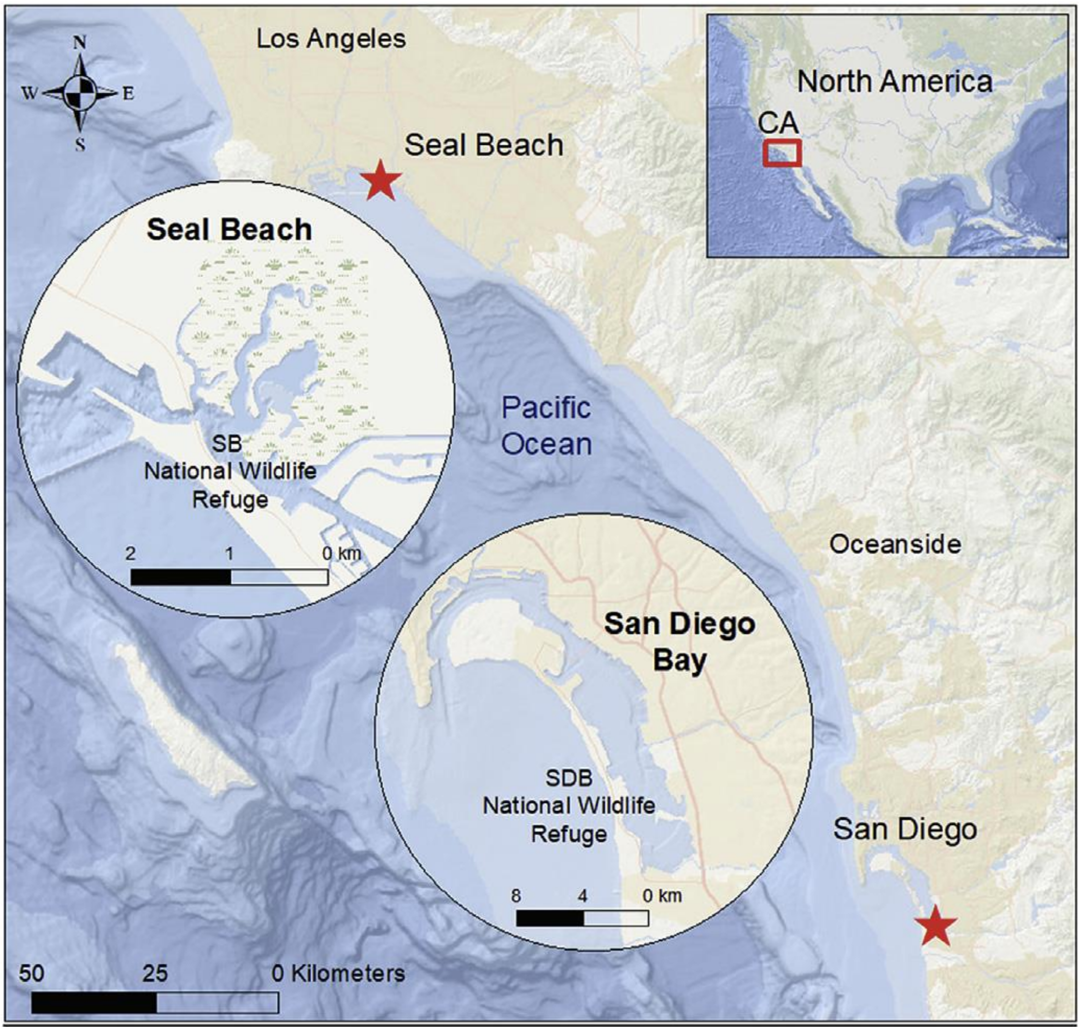


Figure 2. The two green sea turtle foraging sites (red stars) in southern California (CA). Top left circle is the Seal Beach (SB) National Wildlife Refuge; bottom circle is San Diego Bay (SDB) (Barraza, et al. 2019, Ref 6).

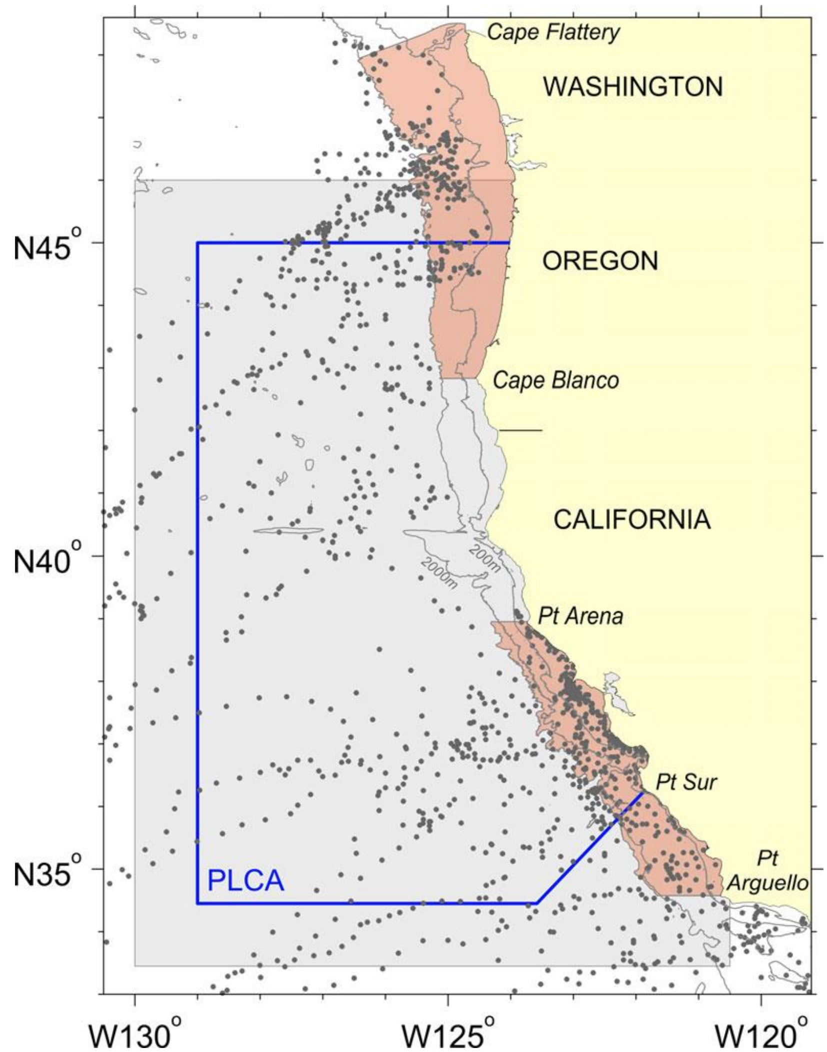


Figure 3. Leatherback telemetry data points (grey circles), assumed foraging areas (light red), and the Pacific leatherback conservation area (PLCA) along the pacific coast of the U.S.A. (Eguchi, et al. 2017, Ref 24).

References

1. Abecassis, M., Senina, I., Lehodey, P., Gaspar, P., Parker, D., Balazs, G., and Polovina, J. 2013. “A Model of Loggerhead Sea Turtle (Caretta Caretta) Habitat and Movement in the Oceanic North Pacific.” *PLoS ONE* 8 (9). https://doi.org/10.1371/journal.pone.0073274.
2. Allen, C.D., Robbins, M.N., Eguchi, T., Owens, D.W., Meylan, A.B., Meylan, P.A., Kellar, N.M., Schwenter, J.A., Nollens, H.H., LeRoux, R.A., Dutton, P.H., Seminoff, J.A. 2015. “First Assessment of the Sex Ratio for an East Pacific Green Sea Turtle Foraging Aggregation: Validation and Application of a Testosterone ELISA.” *PLoS ONE* 10 (10). https://doi.org/10.1371/journal.pone.0138861.
3. Allen, C.D., Lemons, G.E., Eguchi, T., LeRoux, R.A., Fahy, C.C., Dutton, P.H., Peckham,S.H., and Seminoff, J.A. 2013. “Stable Isotope Analysis Reveals Migratory Origin of Loggerhead Turtles in the Southern California Bight.” *Marine Ecology Progress Series* 472 (January): 275–85. https://doi.org/10.3354/meps10023.
4. Bailey, H., Benson, S.R. Shillinger, G.L., Bograd, S. J., Dutton, P.H., Eckert, S.A., Morreale, S.J., Paladina, F.V., Eguchi, T., Foley, D.G., Block, B.A., Piedra, R., Hitipeuw, C., Tapilatu, R.F., Spotila, J.R. 2012. “Identification of Distinct Movement Patterns in Pacific Leatherback Turtle Populations Influenced by Ocean Conditions.” *Ecological Applications* 22 (3): 735–47. https://doi.org/10.1890/11-0633.
5. Barraza, A.D., Komoroske, L.M., Allen, C.D., Eguchi, T., Gossett, R., Holland, E., Lawson, D.D., LeRoux, R.A., Lorenzi, V., Seminoff, J.A., Lowe, C.G. 2020. “Persistent Organic Pollutants in Green Sea Turtles (Chelonia Mydas) Inhabiting Two Urbanized Southern California Habitats.” *Marine Pollution Bulletin* 153 (April): 110979. https://doi.org/10.1016/j.marpolbul.2020.110979.
6. Barraza, A.D., Komoroske, L.M., Allen, C.D., Eguchi, T., Gossett, R., Holland, E., Lawson, D.D., LeRoux, R.A., Long, A., Seminoff, J.A., Lowe, C.G. 2019. “Trace Metals in Green Sea Turtles (Chelonia Mydas) Inhabiting Two Southern California Coastal Estuaries.” *Chemosphere* 223 (May): 342–50. https://doi.org/10.1016/j.chemosphere.2019.01.107.
7. Benson, S.R., Dutton, P.H., Hitipeuw, C., Samber, B., Bakarbessy, J., and Parker, D. 2007. “Post-Nesting Migrations of Leatherback Turtles (Dermochelys Coriacea) from Jamursba-Medi, Bird’s Head Peninsula, Indonesia.” *Chelonian Conservation and Biology* 6 (1): 150–54. https://doi.org/10.2744/1071-8443(2007)6[150:PMOLTD]2.0.CO;2.
8. Benson, S.R., Eguchi, T., Foley, D.G., Forney, K.A., Bailey, H., Hitipeuw, C., Samber, B.P., Tapilatu, R.F., Rei, V., Ramohia, P., Pita, J., Dutton, P.H. 2011. “Large-Scale Movements and High-Use Areas of Western Pacific Leatherback Turtles, Dermochelys Coriacea.” *Ecosphere* 2 (7). https://doi.org/10.1890/ES11-00053.1.
9. Benson, S.R., Forney, K.A., Harvey, J.T., Carretta, J.V., and Dutton, P.H. 2007. “Abundance, Distribution, and Habitat of Leatherback Turtles (Dermochelys Coriacea) off California, 1990−2003.” *Fishery Bulletin* 105 (3): 337–47.
10. Bowen, B.W., Abreu-Grobois, F.A., Balazs, G.H., Kamezaki, N., Limpus, C.J., and Ferl, R.J. 1995. “Trans-Pacific Migrations of the Loggerhead Turtle (Caretta Caretta) Demonstrated with Mitochondrial DNA Markers.” *Proceedings of the National Academy of Sciences* 92 (9): 3731–34. https://doi.org/10.1073/pnas.92.9.3731.
11. Bowlby, C.E., Green, G.A., and Bonnell, M.L. 1994. “Observations of Leatherback Turtles Offshore of Washington and Oregon.” *Northwestern Naturalist* 75 (1): 33–35. https://doi.org/10.2307/3536560.
12. Briscoe, D.K., Parker, D.M., Bograd, S., Hazen, E., Scales, K., Balazs, G.H., Kurita, M., Saito, T., Okamoto, H., Rice, M., Polovina, J.J., Crowder, L.B. 2016. “Multi-Year Tracking Reveals Extensive Pelagic Phase of Juvenile Loggerhead Sea Turtles in the North Pacific.” *Movement Ecology* 4 (1): 23. https://doi.org/10.1186/s40462-016-0087-4.
13. Carretta, J.V., and Enriquez, L. 2007. “Marine Mammal and Sea Turtle Bycatch in the California/Oregon Thresher Shark and Swordfish Drift Gillnet Fishery in 2006.” LJ-07-06. Southwest Fisheries Science Center Administrative Report. NOAA Fisheries, Southwest Fisheries Science Center.
14. Carretta, J.V., and Enriquez, L. 2010. “Marine Mammal and Sea Turtle Bycatch in the California/Oregon Swordfish and Thresher Shark Drift Gillnet Fishery in 2009.” LJ-10-03. La Jolla,

California 92037: Southwest Fisheries Science Center National Marine Fisheries Service National Oceanic & Atmospheric Administration.
15. Carretta, J.V., Enriquez, L., and Villafana, C. 2014. "Marine Mammal, Sea Turtle, and Seabird Bycatch in California Gillnet Fisheries in 2012." LJ-07-06. La Jolla, California 92037: Southwest Fisheries Science Center National Marine Fisheries Service National Oceanic & Atmospheric Administration.
16. Carretta, J.V., Price, T., Petersen, D., and Read, R. 2004. "Estimates of Marine Mammal, Sea Turtle, and Seabird Mortality in the California Drift Gillnet Fishery for Swordfish and Thresher Shark, 1996–2002." *Marine Fisheries Review* 66 (2): 21–25.
17. Crear, D.P., Lawson, D.D., Seminoff, J.A., Eguchi, T., LeRoux, R.A. and Lowe, C.G. 2016. "Seasonal Shifts in the Movement and Distribution of Green Sea Turtles Chelonia Mydas in Response to Anthropogenically Altered Water Temperatures." *Marine Ecology Progress Series* 548 (April): 219–32. https://doi.org/10.3354/meps11696.
18. Crear, D.P., Lawson, D.D., Seminoff, J.A., Eguchi, T., LeRoux, R.A., and Lowe C.G. 2017. "Habitat Use and Behavior of the East Pacific Green Turtle, *Chelonia Mydas* , in an Urbanized System." *Bulletin, Southern California Academy of Sciences* 116 (1): 17–32. https://doi.org/10.3160/soca-116-01-17-32.1.
19. Curtis, K.A., Moore, J.E., and Benson, S.R. 2015. "Estimating Limit Reference Points for Western Pacific Leatherback Turtles (Dermochelys Coriacea) in the U.S. West Coast EEZ." *PLoS ONE* 10 (9). https://doi.org/10.1371/journal.pone.0136452.
20. Dutton, P.H., LeRoux, R.A., LaCasella, E.L., Seminoff, J.A., Eguchi, T., and Dutton, D.L. 2018. "Genetic Analysis and Satellite Tracking Reveal Origin of the Green Turtles in San Diego Bay." *Marine Biology* 166 (1): 3. https://doi.org/10.1007/s00227-018-3446-4.
21. Dutton, P., and McDonald, D. 1990. "Sea Turtles Present in San Diego Bay." Proceedings of the Tenth Annual Workshop on Sea Turtle Biology and Conservation. Hilton Head, South Carolina: Sea World Research Institute, Hubbs Marine Research Center.
22. Eguchi, T., Bredvik, J., Graham, S., LeRoux, R., Saunders, B., Seminoff, J.A. 2020. "Effects of a Power Plant Closure on Home Ranges of Green Turtles in an Urban Foraging Area." *Endangered Species Research* 41 (February): 265–77. https://doi.org/10.3354/esr01027.
23. Eguchi, T. 2015. "Loggerhead Turtles in the Southern California Bight: Insights for the Southern Time-Area Closure." Review of NOAA Fisheries' Science on Marine Mammals & Turtles. La Jolla, CA: NOAA Fisheries, Southwest Fisheries Science Center.
24. Eguchi, T., Benson, S.R., Foley, D.G., and Forney, K.A. 2017. "Predicting Overlap between Drift Gillnet Fishing and Leatherback Turtle Habitat in the California Current Ecosystem." *Fisheries Oceanography* 26 (1): 17–33. https://doi.org/10.1111/fog.12181.
25. Eguchi, T., McClatchie, S., Wilson, C., Benson, S.R., LeRoux, R.A., and Seminoff, J.A. 2018. "Loggerhead Turtles (Caretta Caretta) in the California Current: Abundance, Distribution, and Anomalous Warming of the North Pacific." *Frontiers in Marine Science* 5 (December): 452. https://doi.org/10.3389/fmars.2018.00452.
26. Eguchi, T., Seminoff, J.A., LeRoux, R.A., Dutton, P.H., and Dutton, D.L. 2010. "Abundance and Survival Rates of Green Turtles in an Urban Environment: Coexistence of Humans and an Endangered Species." *Marine Biology* 157 (8): 1869–77. https://doi.org/10.1007/s00227-010-1458-9.
27. Eguchi, T., Seminoff, J.A., LeRoux, R.A., Prosperi, D., Dutton, D.L., and Dutton, P.H. 2012. "Morphology and Growth Rates of the Green Sea Turtle (Chelonia Mydas) in a Northern-Most Temperate Foraging Ground." *Herpetologica* 68 (1): 76–87. https://doi.org/10.1655/HERPETOLOGICA-D-11-00050.1.
28. Finkbeiner, E.M., Wallace, B.P., Moore, J.E., Lewison, R.L., Crowder, L.B., and Read, A.J. 2011. "Cumulative Estimates of Sea Turtle Bycatch and Mortality in USA Fisheries between 1990 and 2007." *Biological Conservation* 144 (11): 2719–27. https://doi.org/10.1016/j.biocon.2011.07.033.
29. Graham, T.R., Harvey, J.T., Benson, S.R., Renfree, J.S., and Demer, D.A. 2010. "The Acoustic Identification and Enumeration of Scyphozoan Jellyfish, Prey for Leatherback Sea Turtles (Dermochelys Coriacea), off Central California." *ICES Journal of Marine Science* 67 (8): 1739–48. https://doi.org/10.1093/icesjms/fsq112.
30. Harris, H.S., Benson, S.R., Gilardi, K.V., Poppenga, R.H., Work, T.M., Dutton, P.H., and Mazet, J.A.K. 2011. "Comparative Health Assessment of Western Paficic Leatherback Turtles (Dermochelys

Coriacea) Foraging off the Coast of California, 2005-2007." *Journal of Wildlife Diseases* 47 (2): 321–37. https://doi.org/10.7589/0090-3558-47.2.321.
31. Harvey, J., Benson, S., and Graham, T. 2006. "Foraging Ecology of Leatherbacks in the California Current." Poster presented at the 26th Annual Symposium on Sea Turtle Biology and Conservation, Island of Crete, Greece.
32. Hodge, R.P., and Wing, B.L. 2000. "Occurrences of Marine Turtles in Alaska Waters: 1960-1998." *Herpetological Review* 31: 148–51.
33. Janisse, C., Squires, D., Seminoff, J.A., and Dutton, P.H. 2020. "Conservation Investments and Mitigation: The California Drift Gillnet Fishery and Pacific Sea Turtles." In *Handbook of Marine Fisheries Conservation and Management*, 231–38. Oxford University Press.
34. Julian, F., and Beeson, M. 1998. "Estimates of Marine Mammal, Turtle, and Seabird Mortality for Two California Gillnet Fisheries: 1990–1995." *Fishery Bulletin* 96 (2): 271–84.
35. Komoroske, L.M., Lewison, R.L., Seminoff, J.A., Deheyn, D.D., and Dutton, P.H. 2011. "Pollutants and the Health of Green Sea Turtles Resident to an Urbanized Estuary in San Diego, CA." *Chemosphere* 84 (5): 544–52. https://doi.org/10.1016/j.chemosphere.2011.04.023.
36. Komoroske, L.M., Lewison, R.L., Seminoff, J.A., Deustchman, D.D., and Deheyn, D.D. 2012. "Trace Metals in an Urbanized Estuarine Sea Turtle Food Web in San Diego Bay, CA." *Science of The Total Environment* 417–418 (February): 108–16. https://doi.org/10.1016/j.scitotenv.2011.12.018.
37. Lemons, G., Lewison, R., Komoroske, L., Gaos, A., Lai, C.T., Dutton, P.H., Eguchi, T., LeRoux, R.A., and Seminoff, J.A. 2011. "Trophic Ecology of Green Sea Turtles in a Highly Urbanized Bay: Insights from Stable Isotopes and Mixing Models." *Journal of Experimental Marine Biology and Ecology* 405 (1): 25–32. https://doi.org/10.1016/j.jembe.2011.05.012.
38. LeRoux, R.A., and Dutton, P.H. 2006. "Genetic Stock Determination of Marine Turtle Bycatch From the California-Based Pelagic Longline Fishery and California/Oregon Drift Gillnet Fishery." Poster presented at the 26th Annual Symposium on Sea Turtle Biology and Conservation, Island of Crete, Greece.
39. MacDonald, B.D., Lewison, R.I., Madrak, S.Y., Seminoff, J.A., and Eguchi, T. 2012. "Home Ranges of East Pacific Green Turtles Chelonia Mydas in a Highly Urbanized Temperate Foraging Ground." *Marine Ecology Progress Series* 461 (August): 211–21. https://doi.org/10.3354/meps09820.
40. MacDonald, B.D., Madrak, S.V., Lewison, R.L., Seminoff, J.A., and Eguchi, T. 2013. "Fine Scale Diel Movement of the East Pacific Green Turtle, Chelonia Mydas, in a Highly Urbanized Foraging Environment." *Journal of Experimental Marine Biology and Ecology* 443 (May): 56–64. https://doi.org/10.1016/j.jembe.2013.02.033.
41. Moore, J.E., Wallace, B.P., Lewison, R.L., Ramúnas Ž., Cox, T.M., and Crowder, L.B. 2009. "A Review of Marine Mammal, Sea Turtle and Seabird Bycatch in USA Fisheries and the Role of Policy in Shaping Management." *Marine Policy* 33 (3): 435–51. https://doi.org/10.1016/j.marpol.2008.09.003.
42. Polovina, J.J., Kobayashi, D.R., Parker, D.M., Seki, M.P., and Balazs, G.H., 2000. "Turtles on the Edge: Movement of Loggerhead Turtles (Caretta Caretta) along Oceanic Fronts, Spanning Longline Fishing Grounds in the Central North Pacific, 1997–1998." *Fisheries Oceanography* 9 (1): 71–82. https://doi.org/10.1046/j.1365-2419.2000.00123.x.
43. Roe, J.H., Morreale, S.J., Paladino, F.V., Shillinger, G.L., Benson, S.R., Eckert, S.A., Bailey, H., Santidrián Tomillo, P., Bograd, S.J., Eguchi, T., Dutton, P.H., Seminoff, J.A., Block, B.A., Spotila, J.R. 2014. "Predicting Bycatch Hotspots for Endangered Leatherback Turtles on Longlines in the Pacific Ocean." *Proceedings of the Royal Society B: Biological Sciences* 281 (1777): 20132559. https://doi.org/10.1098/rspb.2013.2559.
44. Sepulveda, C.A., Heberer, C. and Aalbers, S.A. 2015. "Development and Trial of Deep-Set Buoy Gear for Swordfish, Xiphias Gladius, in the Southern California Bight." *Marine Fisheries Review* 76 (4): 28–36. https://doi.org/10.7755/MFR.76.4.2.
45. Turner-Tomaszewicz, C., and Seminoff, J.A. 2012. "Turning Off the Heat: Impacts of Power Plant Decommissioning on Green Turtle Research in San Diego Bay." *Coastal Management* 40 (1): 73–87. https://doi.org/10.1080/08920753.2012.640267.
46. Wallace, B.P., Lewison, R.L., McDonald, S.L., McDonald, R.K., Kot, C.Y., Kelez, S., Bjorkland, R.K., Finkbeiner, E.M., Helmbrecht, S., and Crowder, L.B. 2010. "Global Patterns of Marine Turtle Bycatch." *Conservation Letters* 3 (3): 131–42. https://doi.org/10.1111/j.1755-263X.2010.00105.x.

47. Welch, H., Hazen, E.L., Briscoe, D.K., Bograd, S.J., Jacox, M.G., Eguchi, T., Benson, S.R., Fahy, C.C., Garfield, T., Robinson, D., Seminoff, J.A., Bailey, H. 2019. “Environmental Indicators to Reduce Loggerhead Turtle Bycatch Offshore of Southern California.” *Ecological Indicators* 98 (March): 657–64. https://doi.org/10.1016/j.ecolind.2018.11.001.
48. California Department of Fish and Wildlife. 2020. “Evaluation of a Petition from Center for Biological Diversity and Turtle Island Restoration Network to List Pacific Leatherback Sea Turtle (*Dermochelys Coriacea*) as Endangered Under the California Endangered Species Act.” State of California Natural Resources Agency Department of Fish and Wildlife.

CHAPTER 2 MEXICO

Updated 2019

Carlos Delgado-Trejo[1], Cutzi Bedolla Ochoa[1], Blanca N. Rangel Aguilar[1], Vianey Nuñez Cárdenas[1], Catherine Hart[2], Karen Oceguera Camacho[2]

[1]Instituto de Investigaciones sobre los Recursos Naturales, Universidad Michoacana de San Nicolás de Hidalgo, Sánchez de Tagle 647, centro, Morelia, Michoacán, CP 58000, México.
[2]Grupo Tortuguero de las Californias, Calle Ficus 108, Colonia Azaleas, CP 23098, La Paz, BCS, México.

Table 1. Main biology and conservation aspects of sea turtles in the Mexican Pacific.

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, 12	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 the Mexican Pacific.

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' 03"	98° 34' 05"	16° 19' 36"			26.0		1,3	2

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°42'22.47"	23°34'44.58"	12.0		1	2
El verde	N	2666 (2015)					106°30'48.11"	23°22'11.36"	28.0		1	2
Playas urbanas de Mazatlán	N	1678 (2015)							21.0		1	2
Isla de la Piedra	N	4553 (2015)					106°24'29.09"	23°11'36.02"	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°51'59.66"	22°42'18.70"	12.0		1	2
Isla del Bosque	N	45 (2015)					105°52'31.57"	22.42'48.87"	6.0		1	2
La Guásima							106°07'22.20"	22°56'11.08"			25	
Teacapan	N	44 (2015)							13.0		1	2
NAYARIT												
Playa de Chila							105°13'14.75"	21°15'22.85"			18	2
Playa de Platanitos							105°14'26.19"	21°21'06.33"			18	2
San Francisco							105°24'51.74"	20°54'16.84"			18	2
El Naranjo							105°13'47.60"	21°05'03.47"			18	2
Nuevo Vallarta	N	5039 ±1705 (2005-2008)					105°17'51.90"	20°41'43.07"			18	2
Bahia de Badera	N	3742 ± 904									18	2
JALISCO												
Boca de Tomates	N	10.121 (2016) #					105°16'26.29"	20°40'13.29"			18	2
Puerto Vallarta	N	10.121 (2016) #									18	2
Mayto	N	10.121 (2016) #					105°34'57.68"	20°15'09.27"			18	2
Teopa			105° 14' 9"	19° 25' 51"	105° 1' 51"	19° 23' 48"			7		25	
Mismaloya							105°29'37.43"	19°59'56.64"			12	2
Chalacatepec							105°40'46.33"	19°40'46.33"			25	
Cuitzmala							105°17'30.66"	20°31'56.76"			25	
La Gloria							105°13'58.16"	20°37'50.68"			25	
Majahuas							105°22'17.77"	19°50'14.68"			25	

COLIMA												
Boca de Apiza							103°4'24.08"	18°41'19.13"			25	
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' 51"	105° 1' 51"	19° 23' 48"			7		63	
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. Organizations and agencies related with sea turtle research and conservation in the Mexican Pacific.

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

Figure 1. Nesting areas located in every state of the Pacific of Mexico.

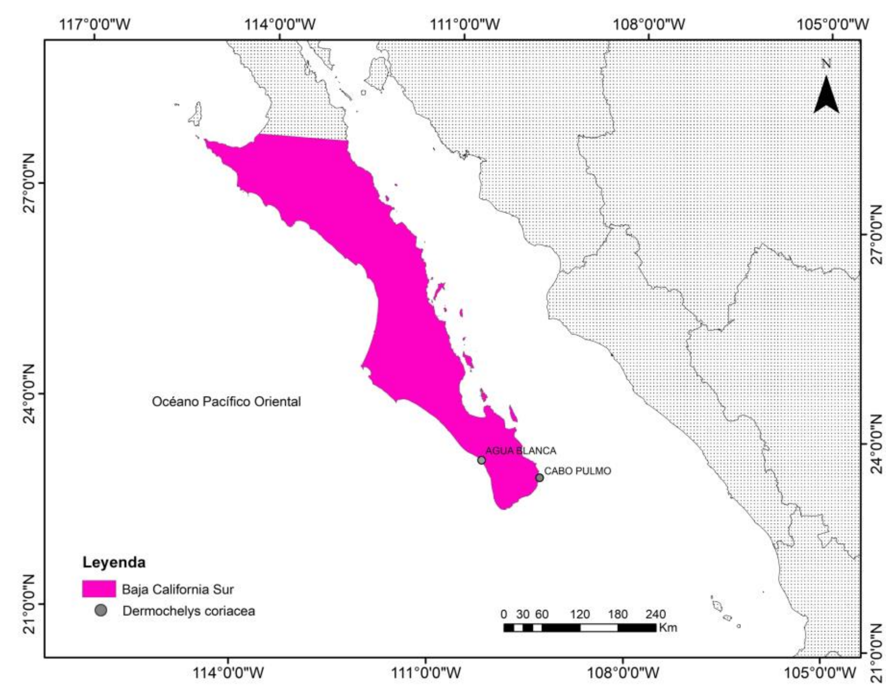


Figure 2. Nesting beaches for *D. coriace* at Baja California Sur state.

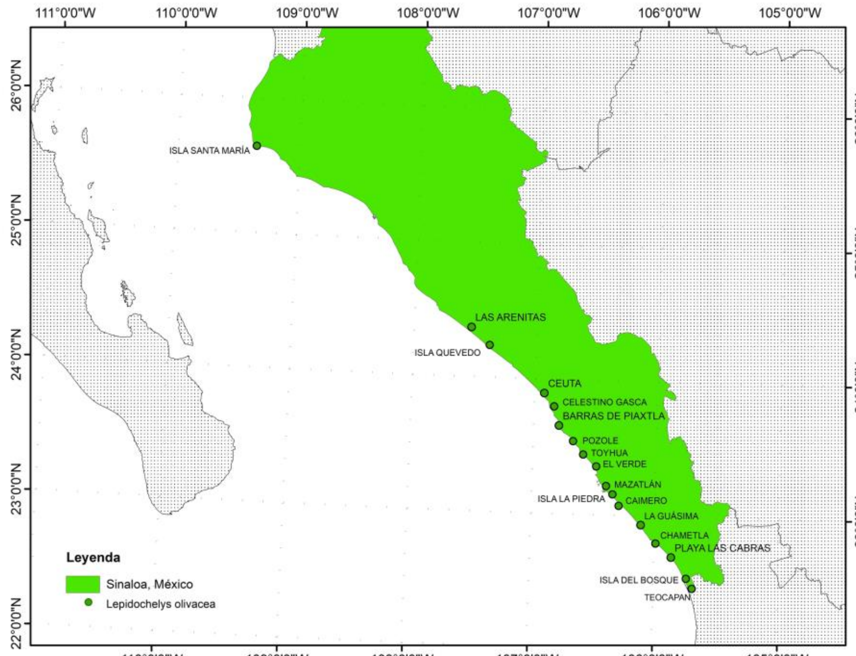


Figure 3. Nesting beaches for *L. olivacea* at Sinaloa state.

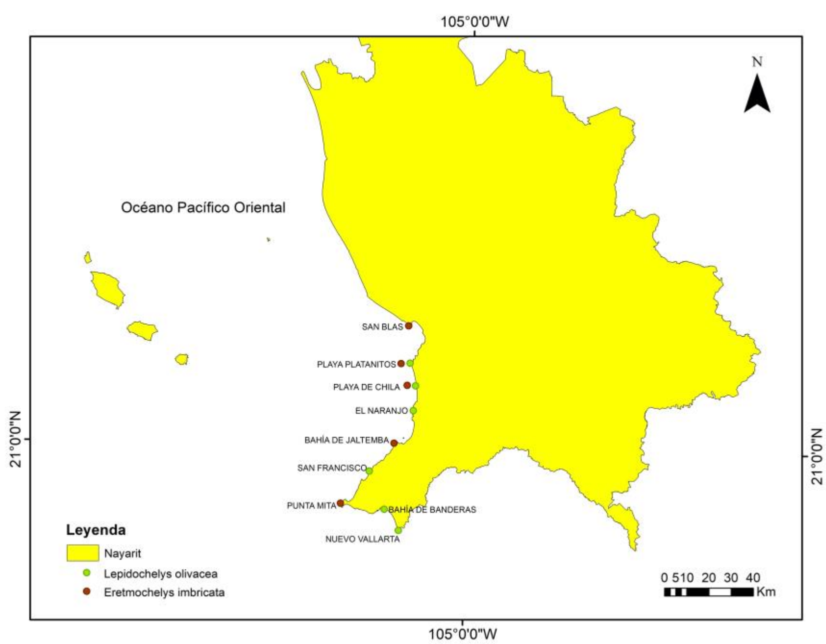


Figure 4. Nesting beaches for *L. olivacea* and *E. imbricata* at Nayarit state.

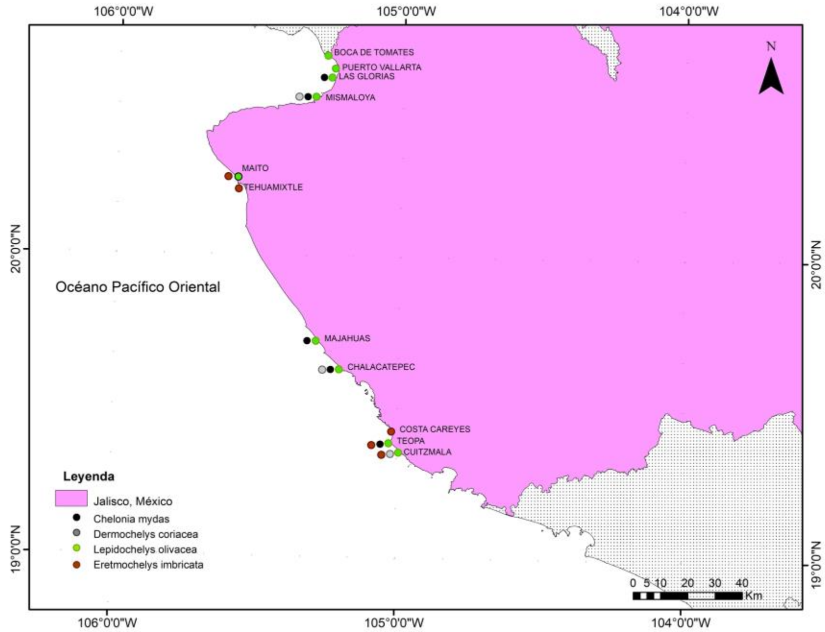


Figure 5. Nesting beaches for *C. mydas*, *D. coriacea*, *L. olivacea*, and *E. imbricata* at Jalisco state.

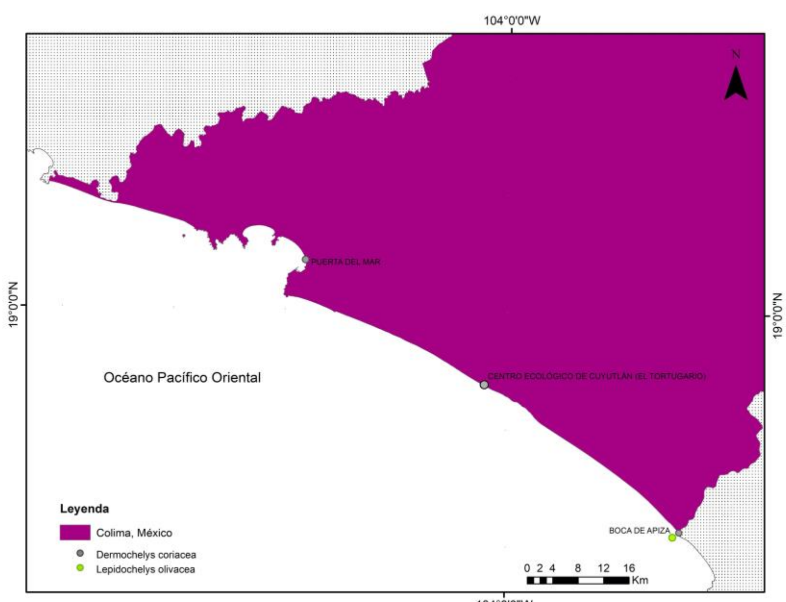


Figure 6. Nesting beaches for *D. coriacea* and *L. olivacea* at Colima state.

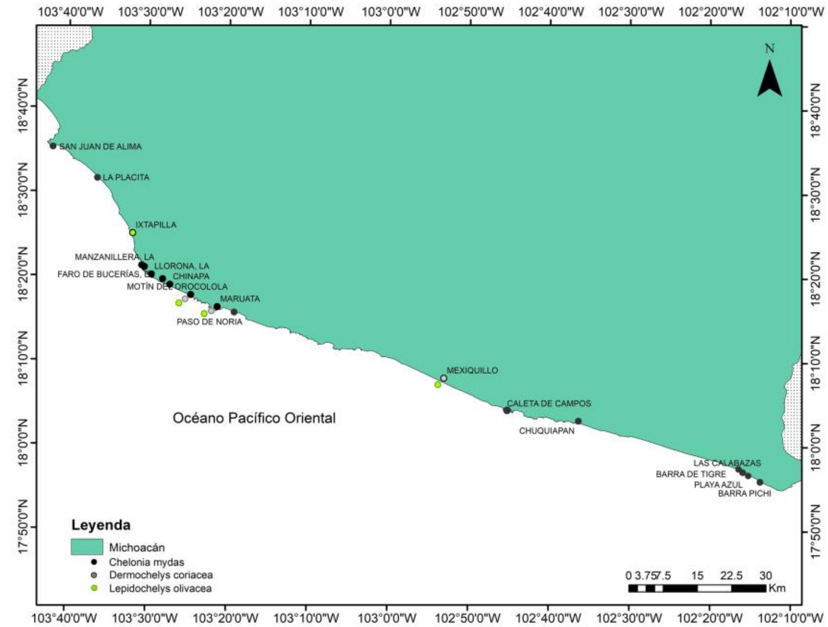


Figure 7. Nesting beaches for *C. mydas*, *D. coriacea*, and *L. olivacea* at Michoacán state.

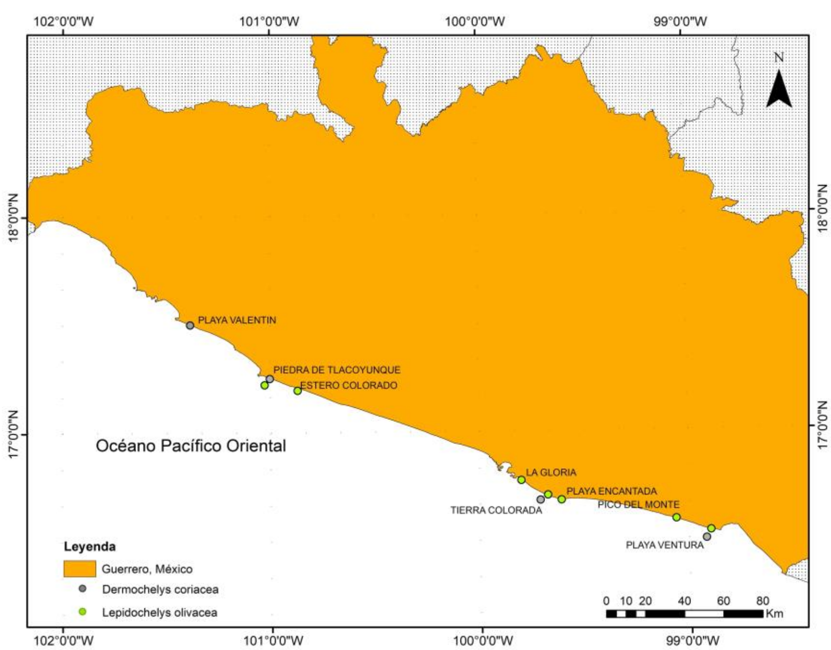


Figure 8. Nesting beaches for *D. coriacea* and *L. olivacea* at Guerrero state.

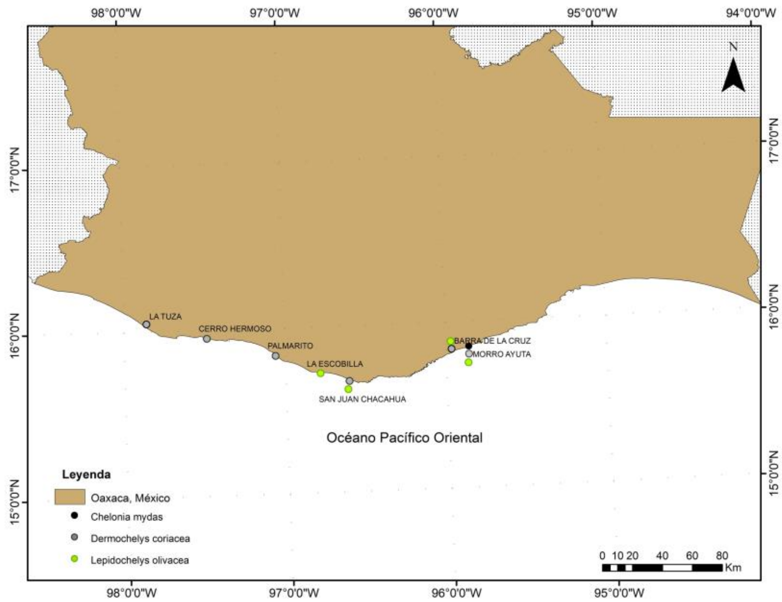


Figure 9. Nesting beaches for *C. mydas*, *D. coriacea*, and *L. olivacea* at Oaxaca state.

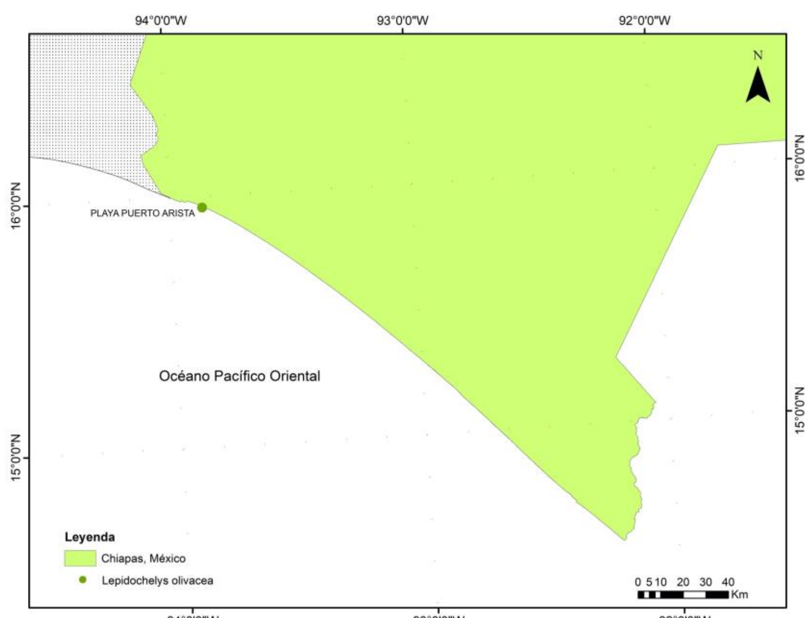


Figure 10. Nesting beach for *L. olivacea* at Chiapas state.

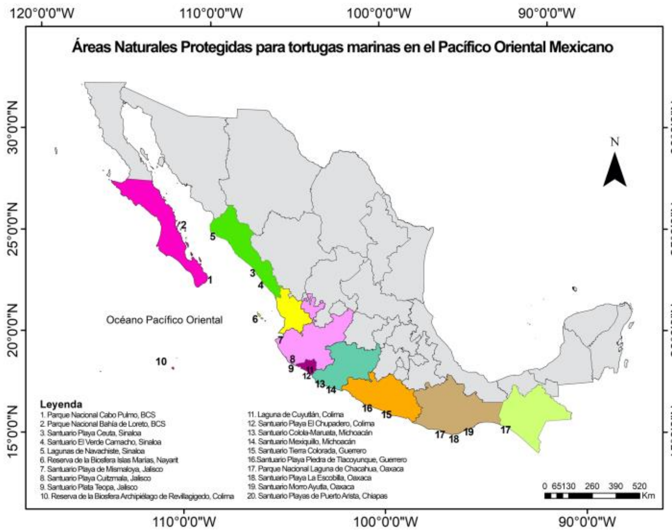


Figure 11. Distribution of marine protected areas for sea turtles in the Pacific of Mexico.

REFERENCES

1. Abreu Grobois, F.A. et al., Las tortugas marinas en Méxic: logros y perspectivas para su conservación, México. (2016).

2. Seminoff, J.A. et al., First direct evidence of migration by an east pacific green sea turtle from Michoacán, México to a feeding ground on the Sonoran coast of the Golf of Califotnia. The southwester Naturalist 42(2):314-316. (2002).

3. Sartí Martínez, L. et al., Conservation and biology of the Leatherback turtle in the Mexican Pacific. México. (2007).

4. Huerta Rodríguez, P. et al., Ficha informativa de los humedales de RAMSAR (FIR); Playón Mexiquillo. México. (2003).

5. Delgado Trejo, C. Ficha infromativa de los humedales de RAMSAR (FIR); Playa de Colola. México. (2007).

6. Delgado Trejo, C. Ficha informativa de los humedales de RAMSAR (FIR); Playa de Maruata. México. (2007).

7. PACE: Programa de ación para la conservación de la especie, tortuga laúd (Dermochelys coriacea). Dirección de especies prioritarias para la conservación. SEMARNAT-CONANP.

8. PACE: Programa de ación para la conservación de la especie, tortuga verde-negra (Chelonia mydas). Dirección de especies prioritarias para la conservación. SEMARNAT-CONANP.

9. PACE: Programa de ación para la conservación de la especie, tortuga golfina (Leidochelys olivacea). Dirección de especies prioritarias para la conservación. SEMARNAT-CONANP.

10. PACE: Programa de ación para la conservación de la especie, tortuga amarilla (Caretta caretta). Dirección de especies prioritarias para la conservación. SEMARNAT-CONANP.

11. Márquez, R. Las tortugas marinas y nuestro tiempo. México. (2002).

12. Alvarado Díaz, J. y Delgado Trejo, C. Tortugas marinas de Michoacán historia natural y conservación. Morelia, Michoacán. (2005).

13. Seminoff, J. A. et al., Loggerhead sea turtle abundance at a foraging hotspot in the eastern Pacific Ocean: implications for at-sea conservation. México. (2014).

14. Allen, C.D. et al., Stable isotope analysis revealsmigratory origin of loggerhead turtles in the Suthern California Bight. (2013).

15. Bowen, BW. et al., Trans-Pacific migations of the loggerhead mitochondrial DNA markers. (1995).

16. Peckham, S. H. et al., Demographic implications of alternative foraging strategies in juvenile leggerhead turtles Caretta caretta of the North Pacific Ocean. México. (2011).

17. Wingfield, D. K. et al., The making of a productivity hotspot in the coastal ocean. México. (2011).

18. Hart, C.E. et al., Status of olive ridley sea turtles (Lepidochelys olivacea) after 29 years of nesting rookery conservation in Nayarit and Bahia de Banderas México. (2018).

19. Alvarado, J. y Figueroa A. The ecological recovery of sea turtles of Michoacán, México. (1990).

20. Alvarado, J y Figueroa, A. Recapturas post-anidatorioas de hembras de tortuga marina negra (Chelonia agassizii) marcadas en Michoacán, México. (1992).

21. Seminoff, J. A. et al., First direct evidence of migration by an East Pacific green sea turtle from Michoacán, México to a feeding ground on the Sonoran coast of the Gulf of California. (2002).

22. Koch, V. 12 años de monitoreo de la tortuga negra (Chelonia mydas agassizii) en los sitios de crianza y alimentación en el noroeste de México. (2013).

23. Márquez, R. Las tortugas marinas y nuestro tiempo. México. (2002).

24. Flore Ramírez, S. et al., Monitoreo de la efectividade del refugío pesquero Golfo de Ulloa, Baja California Sur. México. (2017).

25. Briseño Dueñas, R. y F. A. Abreu Grobois. Las tortugas y sus playas de anidación en México. Universidad Nacional Autónoma deMéxico. Instituto de Ciencias del Mar y Limnología. Informe final SNIBCONABIO. Proyecto No. P066. México D. F. (1998).

26. Flores Monter, Y. et al., Análisis multicriterio del impacto potencial del turismo en la anidación de las tortugas marinas en Chalacatepec, Jalisco. Nova scientia. México. (2015).

27. Bárcenas Ibarra, A. Diferenciación genética de las colonias anidantes de tortuga golfina (Lepidochelys olivacea) en el Pacifico Mexicano con base en análisis de ADN mitocondrial. Centro de Investigación Científica y de Educación Superior de Ensenada Baja California. 91 pp. (2009).

28. Labrada Mortagón, V. Evaluación del estado de salud de la tortuga verde del Pacifico Oriental (Chelonia mydas) que habita en la costa de Baja California Sur, a través de biomarcadores fisiológicos. Centro de Investigaciones Biológicas del Noroeste, S.C. (2011).

29. Rguez-Baron, J.M. Afinidad trófica a zonas de alimentación de la tortuga verde (Chelonia mydas) en la costa Occidental de Baja California Sur, México. Instituto Politécnico Nacional. Centro Interdisciplinario de las Ciencias Marinas, La Paz, B. C. S. México. (2010).

30. Santos Baca M. L. Evaluación de los hábitos de alimentación de la tortuga verde (Chelonia mydas), en Bahía Magdalena, BCS. México utilizando la técnica de isótopos estables (δ 13 C y δ 15 N). Tesis de Maestría. Centro de Investigaciones Biologicas del Noroeste, S. C. 90 pp. (2008).

31. Hernandez Cruz, G. Análisis de la captura diurna y nocturna y estado de la población de tortuga prieta (Chelonia mydas)en laguna Ojo de Liebre, Baja Califonia Sur: 2009-2012. Centro de Investigación Científica y de Educación Superior de Ensenada, Baja California. (2013).

32. Casas-Andreu, G. y Gómez Aguirre, S. Contribución al conocimiento de los hábitos alimenticios de Lepidochelys olivacea y Chelonia mydas agassizi (Reptilia, Chelonidae) en el Pacífico Mexicano. Rev. Bolm Inst. oceanogr., S. Paulo, 29 (2), 87-89, 1980

33. Fitzgerald S. L. Los Metales Pesados en Cuatro Especies de Tortugas Marinas de Baja California México. (2004).

34. Rodriguez-Zarate C. et al. Gentic signatureof a recent metapopulation bottleneck in the olive ridley turtle (Lepidochelys olivacea) after intensive commercial exploitation in mexico. Rev. Biological Conservation 168 (2013) 10- 18.

35. Bárcenas Ibarra A. y Maldonado Gasca A. Malformations in embryos and neonates of olive sea turtle (Lepidochelys olivacea) in Nuevo Vallarta Nayarit Mexico. Rev. Vet. Méx., 40 (4) 2009.

36. Hart, E. C. et al., En búsuqeda de las ultimas careyes del Pacífico Mexicano. GrGrupo Tortuguero de las Californias A.C., Investigación, Capacitación y Soluciones Ambientales y Sociales A.C. Tepic, Nayarit, México., Eastern Pacific Hawksbill Initiative, San Diego, California, USA., Eco-Mayto A.C., Instituto Politécnico Nacional, CIIDIR-SINALOA., Centro de Protección y Conservación de Tortugas Marinas Playa Teopa, Jalisco, México. Memorias Reunión Nacional sobre Tortugas Marinas en México. Morelia, México. (2017).

37. Hart, E. C. Estatus y conservación de las tortugas marinas en las costas de Nayarit y del norte de Jalisco. Tesis doctoral. Centro Universitario de la Costa. México. (2016).

38. Eckert, S.A. y L. Sarti. Distant fisheries implicated in the loss of the world's largest leatherback nesting population. Marine Turtle Newsletter 78:2. (1997).

39. Musick, J. y C. Limpus. Habitat utilization and migration in juvenile sea turtle. The Biology of Sea Turtles. (1997).

40. Nichols, W.J.., A. Resendiz, J. Seminoff y B. Resendiz. Transpacific migration of a loggerhead turtle monitored by satellite telemetry. Buletin of Marine Science. (2000).

41. Bolten A. B., K. A. Bjorndal, H. R. Martins, T. Dellinger, M. J. Biscoito, E.E. Encalada y B.W. Bowen. Transatlantic decelopmental migrations of loggerhead sea turtles demostrataed by mtDNA sequence analysis. Ecological Applications 8:1-7. (1998).

42. García MendoZA, ML. Varamiento de tortugas marinas en playa Ceuta, Sinaloa 2006-200. Tesis de Licenciatura. Universidade de Sinaloa. (2014).

43. Gardner, S.C., Nichols, W. J. Assessment of sea turte mortality rates in the Bahía Magdalena region, Baja California Sur, México. Chelonia Conserv. Biol 4, 197-199. (2001).

44. Márquez, R. y Guzmán, V. Registros de la captura comercial de la tortuga de carey (Eretmochelys imbricata)en el Golfo de México y la Península de Yucatán entre 1953 y 1989. Memorias CONANP/EPC/APFFLT/PNCTM. (2008).

45. Santidrián-Tomillo, P., et al., Climate driven egg and hatchling mortality threatens survival of Eastern Pacific . (2012).

46. Campbell, C. Estado de conservación de la tortuga carey en las regiones del gran Caribe, Atlantico Occidental y Pacífico Oriental. CIT Secretaría Pro Tempore. (2014).

47. Dewald, J.R. y Pike, D. A. Geographial variation in hurricane impacts among sea turtle populations. Journal of Biogeography, 41:307-316. (2014).

48. Verutes, G.M, et al., Exploring scenarios of light pollution from coastal development reaching sea turtle nesting beaches near Cabo Pulmo, México. Global Ecology and Conservation, 2:170-180. (2014).

49. Wedemeyer-Strombel, K.R. et al., High frequency of occurrence of anthropogenic debris ingestión by sea turtles in the North Pacific Ocean. Marine Biology. (2015).

50. Howell, E. A. et al., Oceanographic influences on the dive behavior of juvenile loggerhead turtles (Caretta caretta) in the North Pacific Ocean. Marine Biology 157(5):1011-1026. (2010).

51. Kobayashi, D. R. et al., Pelagic habitat characterization of loggerhead sea turtles, Caretta caretta, in the North Pacific Ocean (1997-2006): insights from satellite tag tracking and remotely sensed data. Journal of Experimental Marine Bioly and Ecology356:96-114. (2008).

52. Koch, V. et al., Estimates of sea turtles mortality from poaching and bycatch in Bahia Magdalena, Baja California Sur, México. Biological Conservation 128(3): 327-334. (2006).

53. Mancini, A. Incidental bycatch or directed harvest? Mortality rates of sea turtle in Baja California Sur. Thesis in Marine and Coastal Science (CIMACO) UABCS, México. (2009).

54. Peckham, S. H. et al., Mortality of loggerhead turtles due to bycatch, human consumption and strandings at Baja California Sur, México, 2003-200. Endangered Species Research 5:171-183. (2008).

55. Peckham, S. H. et al., Demographic implications of alternative foraging strategies of the North Pacific Ocean. Mar Ecol Prog Ser. 425:269-280. (2011).

56. Peckham, S. H. et al., A market-based bycatch solution? Substituting hook for gillnet fishing to spare North Pacific loggerheads in proceeding of the Thirty-first Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NOAA NMFS-SEFSC-631, San Diego, USA. (2011).

57. Peckham, S. H. et al., Bycatch mass mortality of loggerhead turtles at NW México. In: Proceedings of the 33rd International Sympsium on sea turtle biology and conservation, Blatimore. (2013).

58. Ramírez-Cruz, J. C., Ramírez I. P. Y Flores, D. V. Distribución y abundancia de la tortuga perica en la costa occidental de Baja California Sur, México. Archelon 1:1-4. (1991).

59. Sarti, Martínez A. L. Propuesta para el cierre temporal de áreas a las pesquerias frente a las costas en el Pacífico Mexicano para la proteción de la tortuga laúd. SEMARTNAT 2004.

60. Seeminoff, J. A., J. Alvarado, C.Delgado, J.L. dance of migration by an East Pacific green sea turtle from Michoacán, México to a feeding ground on the Sonoroan coast of the Gulf of California. The southwetern Naturalist 47 (2):314-316.

61. Vasconcelos, P.J., C. Peñaflores S. &E, Albavera. (2000). Seguimiento de la migración por medio de tranmisores de satélite, de dos ejemplares de tortuga golfina, Lepidochelys olvacea, que anidaron en la playa de la Escobilla, Oax., en el Pacífico Sur. XII Congreso Nacional de Oceanografia. 22 al 26 de mayo 2000.

62. Hart, C. E., Zavala-Norzagaray, A. A., Benítez-Luna, O., Plata-Rosas, L. J., Abreu-Grobois, F. A., & Ley-Quiñonez, C. P. (2016). Effects of incubation technique on proxies for olive ridley sea turtle (Lepidochelys olivacea) neonate fitness. Amphibia-Reptilia, 37(4), 417-426.

63. ICAPO. Memorias del Primer Taller sobre la Tortuga Carey en el Pacífico Oriental. 15-17, Los Cóbanos, El Salvador. 27p. (2008).

64. Delgado, Trejo C. Historia de vida y conservación de la población de tortuga negra (Chelonia agassizii) que anida en Michoacán. Tesis de Maestría, Facultad de Biología, Universidad Michoacana de San Nicolás de Hidalgo.

65. Rangel, Aguilar B. N. Desplazamiento temporal de la actividad anidatorio y tendencias en el tamaño de nidada de tortuga negra (Chelonia mydas agassizii) desde 1995-2011. Facultade de Biología, Universidad Michoacana de San Nicolás de Hidalgo. (2014).

66. Bedolla, O., C. Tamaño Corporal de la Tortuga Negra (Chelonia agassizii, Bocourt, 1868) y su Relación con Características Reproductivas en Hembras Reclutas y Remigrantes de la Población Anidadora de Colola, Michoacán, México. Tesis de Licenciatura, Facultad de Biología, Universidad Michoacana de San Nicolás de Hidalgo. (2003).

67. Calvillo, G., Y. Comportamiento de la anidación de tortuga negra (Chelonia agassizii) en la playa de Colola, Michoacán en relación a aspectos climáticos locales y globales. Tesis de Licenciatura, Facultad de Biología, Universidad Michoacana de San Nicolás de Hidalgo. (2007).

CHAPTER 3 EL SALVADOR

Updated 2019

Michael Liles[1,2], Ana Enríquez[1,2], Fernando Medina[3]

[1]ProCosta, Prados de San Luis Poligono F 33, San Salvador, El Salvador
[2]Eastern Pacific Hawksbill Initiative (ICAPO), 2965 Redwood Street, San Diego, CA, U.S.A.
[3]Fundación Domenech, 89 Avenida Norte 515, San Salvador, El Salvador

Table 1. Main biology and conservation aspects of sea turtles in the El Salvador.

RMU	Pacífico Oriental							
	LO	Ref #	CM	Ref #	DC	Ref #	EI	Ref #
Ocurrencias								
Sitios de Anidación	Y	1,2	Y	1,2	Y	1,2	Y	3,4,5,6,7
Sitios de Forrajeo Pelágicos	JA	8	JA	9	n/a		n/a	
Sitios de Forrajeo Bénticos	JA	9,10	JA	9,10, 11	n/a		JA	5,9,12,13,14 ,15,22
Datos biológicos de importancia								
Anidación/por año: promedio actual (rango de años)	>14,554* (2009-2016)	16	>19.6^ (2009-2016)	16	>9.0 (1995-2015)	17	251 (2008-2015)	3,4,5,6,7
Anidación/por año: orden de magnitud actual	n/a		n/a		n/a		n/a	
Número de sitios con abundancia de anidación (>20 nidos/por año Y >10 nidos/km por año)	≥36	16	0	16	0	16,17	3	5,6,7
Número de sitios con menor anidación (<20 nidos/por año ó <10 nidos/km por año)	0	16	≥19	16	≥18	16,17	≥7	16
Nidos/por año en sitios de abundancia: promedo actual (rango de años)	>14,554* (2009-2016)	16	n/a		n/a		245.7 (2008-2016)	5,6,7
Nidos/por año en sitios con menor anidación: promedio actual (rango de años)	n/a		>19.6^ (2009-2016)	16	>9.0 (1995-2015)	16,17	8.5 (2009-2016)	16
Largo total de sitios de anidación (km)	177.5	PS	115.5	PS	110.7	PS	87.1	5,6,7, PS
Hembras anidantes / por año	n/a		n/a		n/a		90	6,7,18
Nidos / temporada de anidación (N)	n/a		n/a		n/a		2.1 (190)	7,18
Intervalo de remigración de hembras(años) (N)	n/a		n/a		n/a		2.1 (54)	7,18
Radio sexual: Neonatos (hembras / Total) (N)	n/a		n/a		n/a		0.69-0.85 (705 clutches)	PS
Radio sexual: Inmaduras (hembra / Total) (N)	n/a		n/a		n/a		0.86 (77)	PS
Radio sexual: Adulta (hembra / Total) (N)	n/a		n/a		n/a		0.53-0.61 (41 clutches from 34 females)	19
Min medidas adultos, LCC (cm)	n/a		n/a		n/a		Bahía de Jiquilisco = 71.0; Punta Amapala = 62.2	7
Edad de madurez (yrs)	n/a		n/a		n/a		n/a	

Tamaño del nidos (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)	7
Éxito de eclosión (neonatos/huevos) (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); Punta Amapala = 0.72 (93)	7
Nesting success (Nidos/ huellas totales) (N)	n/a		n/a		n/a		n/a	
Tendencias								
Tendencias actuales (últimos 20 años) en los sitios de anidación (rango de años)	n/a		n/a		n/a		n/a	
Tendencias actuales (últimos 20 años) en los sitios de forrajeo (rango de años)	n/a		n/a		n/a		n/a	
Mayor abundancia documentada: nido/año (rango de años)	22,184 (2010)	16	76 (2012)	16	32 (2014-2015)	17	322 (2015)	7,16
Estudios Publicados								
Tasas de crecmiento	N		N		N		N	
Genética	N		N		N		Y	19,20,21,22
Stocks definidos por marcadores genéticos	N		N		N		Y	20,21,22
Rastreo remoto (satelital u otro)	N		N		N		Y	12,13,23
Tasas de sobrevivencia	N		N		N		N	
Dinámica de la población	N		N		N		N	
Ecología de forrajeo (dieta/ isotopos)	N		Y	11	N		Y	15
Captura- Marca -Recaptura	N		Y	11	N		Y	6,7,15
Amenazas								

Bycatch: presencia a menor escala / pesca artesanal?	Y (PLL)	8	n/a		n/a		Y (SN, OTH)	5,14
Bycatch: presencia de pesca industria?	Y (ST)	10	Y (ST)	10	n/a		n/a	
Bycatch: cuantificada?	N		N		N		Y	14
Take. Mortalidad intencionada/ pesca con bomba	n/a		n/a		n/a		Y (pesca con bomba)	4,5
Take. Saqueo de huevos	Y	2	Y	2	Y	2,17	Y	2,3,4,5,18,2 5
Desarrollo costero. Degradación del hábitat de anidación	Y	24	Y	24	Y	24	Y	3,4,6,24
Desarrollo costero. Contaminación lumínica	Y	24	Y	24	Y	24	Y	24
Desarrollo costero. Golpes de botes	n/a		Y	PS	n/a		Y	PS
Depredación de huevos	n/a		n/a		n/a		Y	PS
Contaminación (debris, química)	n/a		n/a		n/a		Y	26
Patógenos	n/a		n/a		n/a		n/a	
Cambio Climático	n/a		n/a		n/a		n/a	
Degradación del hábitat de forrajeo	n/a		Y	27	n/a		Y	13
Otros	Y (see text)	28	Y (see text)	28	n/a		n/a	
Proyectos a largo plazo								
Monitoreo en sitios de anidación	Y	16	Y	16	Y	16,17	Y	3,4,5,6,7
Número de sitios de anidación identificados	≥36	16	≥19	16	≥18	17	10	3,4,5,6,7,16
Monitoreo en sitios de forrajeo	N		Y	11	N		Y	15
Conservación								
Protección bajo la ley nacional	Y	25	Y	25	Y	25	Y	25
Número de sitios de anidacieon protejidos (preservación de hábitat)	2	31,32 ,33	2	31,32 ,33	2	31,32 ,33	2	31,32
Número de áreas marinas con mitigación de amenazas	n/a		n/a		n/a		3	PS
Proyectos de conservación a largo plazo (número)	≥20	16	1		1		3	7
Protección de nidos In- Situ (ej. jaulas)	Y		N		N		Y	6
Viveros	Y	16	Y	16	Y	16	Y	5,6,7,16
Head-starting	N		N		N		N	

By-catch: Modificación en los aparejos de pesca (ej, DET, canzuelos circulares)	Y (ST, PLL)	8,10	Y (ST, PLL)	8,10	n/a		Y (SN)	14
By-catch: buenas prácticas abordo	N		N		N		Y	14
By-catch: vedas/reducción	Y (ST)	30	Y (ST)	30	n/a		Y (SN)	29
Otros	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 the El Salvador.

Especie / RMU	Index site	Nidos/año: promedio actual (rango de años)	Punto Central		Largo (km)	% Monitoreado	# Referencia	Nivel de monitoreo (1-2)	Protocolo de monitoreo (A-F)
Departamento			Long	Lat					
Playa de anidación									
LO-EPO*									
Ahuachapán									
Bola de Monte	N	370.5 (2009, 2012)	-90.110254°	13.735812°	4.0	100.0	16	2	B
Garita Palmera	N	230.5 (2009, 2012)	-90.070928°	13.719591°	6.7	100.0	16	2	B
ANP Barra de Santiago	N	418.5 (2009, 2012)	-90.012507°	13.693083°	5.6	100.0	16	2	B
Sonsonate									
Metalío	N	405.0 (2012)	-89.891733°	13.632187°	6.0	100.0	16	2	B
ANP Los Cóbanos	Y	1255.0 (2009, 2012)	-89.807170°	13.524219°	7.8	100.0	16	2	B
Barra Ciega	N	197.5 (2009, 2012)	-89.712139°	13.528635°	2.0	100.0	16	2	B
Playa Dorada	N	750.7 (2009, 2012, 2016)	-89.654950°	13.529289°	4.9	100.0	16	2	B
La Libertad									
El Zonte	N	26.0 (2009)	-89.442071°	13.495081°	1.9	100.0	16	2	B
El Majahual	N	227.0 (2009)	-89.365790°	13.490160°	1.5	100.0	16	2	B
San Blas	N	144.0 (2009, 2012, 2016)	-89.357605°	13.486021°	1.6	100.0	16	2	B

San Diego	Y	1381.3 (2009, 2012, 2016)	-89.278185°	13.477297°	9.0	100.0	16	2	B
El Amatal	N	339.0 (2009, 2012, 2016)	-89.242829°	13.461899°	1.0	100.0	16	2	B
Toluca	Y	823.5 (2009, 2012)	-89.225890°	13.453534°	3.9	100.0	16	2	B
Boca Poza	N	142.0 (2009)	-89.204077°	13.442142°	1.5	100.0	16	2	B
Los Pinos/Cangrejera	N	771.5 (2009, 2012)	-89.183532°	13.432252°	4.1	100.0	16	2	B
La Paz									
Las Bocanitas	N	416.5 (2009, 2012)	-89.162258°	13.421546°	1.6	100.0	16	2	B
Amatecampo	N	405.0 (2009, 2012)	-89.143259°	13.411992°	1.8	100.0	16	2	B
La Zunganera	N	382.0 (2009, 2012)	-89.124908°	13.402021°	2.8	100.0	16	2	B
El Pimental	N	520.5 (2009, 2012)	-89.079360°	13.376987°	4.5	100.0	16	2	B
San Marcelino/Las Hojas	N	360.0 (2016)	-89.042070°	13.357346°	4.9	100.0	16	2	B
Costa del Sol	N	673.7 (2009, 2011-2016)	-88.922981°	13.306390°	13.7	100.0	16	2	B
Isla Tasajera	Y	1036.0 (2009, 2012, 2016)	-88.853545°	13.270221°	6.9	100.0	16	2	B
San Vicente									
Isla Montecristo	N	777.7 (2009, 2012-2016)	-88.788574°	13.244457°	7.0	100.0	16	2	B
Usulután									
San Juan del Gozo	N	743.0 (2009, 2012)	-88.751490°	13.232316°	3.0	100.0	16	2	B
Isla de Méndez	N	723.5 (2009, 2012)	-88.715585°	13.224762°	5.6	100.0	16	2	B

Ceiba Doblada	N	282.5 (2012)	-88.644276°	13.213307°	8.5	100.0	16	2	B
Corral de Mulas	N	471.0 (2009-2011)	-88.542621°	13.192864°	4.7	100.0	16	2	B
El Icaco	N	484.5 (2009, 2011)	-88.525353°	13.186542°	2.5	100.0	16	2	B
Punta San Juan	N	227.0 (2011)	-88.489407°	13.176040°	7.4	100.0	16	2	B
Isla San Sebastián	N	684.0 (2009, 2012, 2016)	-88.408611°	13.162931°	12.6	100.0	16	2	B
El Espino	N	241.7 (2009, 2012, 2016)	-88.303310°	13.172478°	6.5	100.0	16	2	B
Salamar	N	92.5 (2009, 2012)	-88.235933°	13.163123°	2.8	100.0	16	2	B
La Unión									
El Icacal	N	137.0 (2009, 2012, 2016)	-88.015986°	13.165526°	9.4	100.0	16	2	B
Punta Amapala	N	170.5 (2012, 2016)	-87.936131°	13.159791°	6.5	100.0	16	2	B
El Tamarindo	N	61.4 (2009-2010, 2012-2016)	-87.916344°	13.183208°	1.9	100.0	16	2	B
El Majahual (Isla Meanguera)	N	49.0 (2009, 2016)	-87.709121°	13.170171°	1.4	100.0	16	2	B
CM-EPO^									
Sonsonate									
ANP Los Cóbanos	N	1.3 (2009, 2012, 2016)	-89.807170°	13.524219°	7.8	100.0	16	2	B
Barra Ciega	N	0.5 (2009, 2012)	-89.712139°	13.528635°	2.0	100.0	16	2	B
Playa Dorada	N	1.0 (2009, 2012, 2016)	-89.654950°	13.529289°	4.9	100.0	16	2	B

La Libertad	N									
San Diego	N	0.3 (2009, 2012, 2016)	-89.654950°	13.529289°	9.0	100.0	16	2	B	
La Paz										
El Pimental	N	2.5 (2009, 2012)	-89.079360°	13.376987°	4.5	100.0	16	2	B	
San Marcelino/Las Hojas	N	1.0 (2016)	-89.042070°	13.357346°	4.9	100.0	16	2	B	
Costa del Sol	N	2.7 (2009, 2011-2016)	-88.922981°	13.306390°	13.7	100.0	16	2	B	
Isla Tasajera	N	3.7 (2009, 2012, 2016)	-88.853545°	13.270221°	6.9	100.0	16	2	B	
San Vicente										
Isla Montecristo	N	1.0 (2009, 2012-2016)	-88.788574°	13.244457°	7.0	100.0	16	2	B	
Usulután										
Isla de Méndez	N	1.0 (2012)	-88.715585°	13.224762°	5.6	100.0	16	2	B	
Corral de Mulas	N	1.0 (2009-2011)	-88.542621°	13.192864°	4.7	100.0	16	2	B	
El Icaco	N	3.5 (2009, 2011)	-88.525353°	13.186542°	2.5	100.0	16	2	B	
Punta San Juan	Y	6.0 (2011-2016)	-88.489407°	13.176040°	7.4	100.0	16,PS	2	B	
Isla San Sebastián	N	0.9 (2009, 2011-2016)	-88.408611°	13.162931°	12.6	100.0	16	2	B	
Salamar	Y	8.7 (2009, 2012, 2016)	-88.235933°	13.163123°	2.8	100.0	16	2	B	
La Unión										
El Icacal	N	5.7 (2009, 2012, 2016)	-88.015986°	13.165526°	9.4	100.0	16	2	B	

Punta Amapala	N	2.7 (2009, 2012, 2016)	-87.936131°	13.159791°	6.5	100.0	16	2	B
El Tamarindo	N	0.1 (2009-2010, 2012-2016)	-87.916344°	13.183208°	1.9	100.0	16	2	B
El Majahual (Isla Meanguera)	N	0.5 (2009, 2016)	-87.709121°	13.170171°	1.4	100.0	16	2	B
DC-EPO[$]									
Ahuachapán									
Garita Palmera	N	0.5 (2009, 2012)	-90.070928°	13.719591°	6.7	100.0	16	2	B
ANP Barra de Santiago	N	1.0 (2009, 2012, 2014)	-90.012507°	13.693083°	5.6	100.0	16,17	2	B
Sonsonate									
ANP Los Cóbanos	N	0.5 (2009, 2012, 2014, 2016)	-89.807170°	13.524219°	7.8	100.0	16,17	2	B
Barra Ciega	N	0.3 (2009, 2012, 2014)	-89.712139°	13.528635°	2.0	100.0	16,17	2	B
La Libertad									
San Diego	N	0.8 (2009, 2012, 2014, 2016)	-89.654950°	13.529289°	9.0	100.0	16,17	2	B
El Amatal	N	0.3 (2009, 2012, 2016)	-89.242829°	13.461899°	1.0	100.0	16,17	2	B
Los Pinos/Cangrejera	Y	2.0 (2009, 2012, 2014)	-89.183532°	13.432252°	4.1	100.0	16,17	2	B
La Paz									
La Zunganera	N	0.7 (2009, 2012, 2014)	-89.124908°	13.402021°	2.8	100.0	16,17	2	B
El Pimental	Y	1.7 (2009, 2012, 2014)	-89.079360°	13.376987°	4.5	100.0	16,17	2	B
Costa del Sol	N	1.1 (2009, 2011-2016)	-88.922981°	13.306390°	13.7	100.0	16,17	2	B

Usulután									
San Juan del Gozo	N	0.3 (2009, 2012, 2014)	-88.751490°	13.232316°	3.0	100.0	16,17	2	B
Isla de Méndez	Y	2.0 (2009, 2012)	-88.715585°	13.224762°	5.6	100.0	16,17	2	B
El Icaco	N	0.7 (2009, 2011, 2014)	-88.525353°	13.186542°	2.5	100.0	16	2	B
Punta San Juan	N	0.5 (2011-2012)	-88.489407°	13.176040°	7.4	100.0	16	2	B
Isla San Sebastián	Y	1.5 (2009, 2012, 2014, 2016)	-88.408611°	13.162931°	12.6	100.0	16,17	2	B
El Espino	N	0.5 (2009, 2012, 2014, 2016)	-88.303310°	13.172478°	6.5	100.0	16,17	2	B
La Unión									
El Icacal	Y	1.7 (2009, 2012, 2016)	-88.015986°	13.165526°	9.4	100.0	16	2	B
Punta Amapala	N	0.7 (2009, 2012, 2016)	-87.936131°	13.159791°	6.5	100.0	16	2	B
EI-EPO									
Ahuachapán									
Garita Palmera[%]	N	1.0 (2009)	-90.070928°	13.719591°	6.7	100.0	16	2	B
Sonsonate									
ANP Los Cóbanos	Y	51.1 (2008-2010, 2012, 2014-2016)	-89.807170°	13.524219°	7.8	100.0	5,6,7,16	1	B
Barra Ciega[%]	N	1.0 (2009, 2012)	-89.712139°	13.528635°	2.0	100.0	16	2	B
Usulután									
Bahía de Jiquilisco (inshore beaches)	Y	172.1 (2008-2016)			42.1	100.0	5,6,7,16	1	B
El Espino	N	0.3 (2009, 2012, 2016)	-88.303310°	13.172478°	6.5	100.0	16	2	B

Salamar	N	1.0 (2009, 2012)	-88.235933°	13.163123°	2.8	100.0	16	2	B
La Unión									
El Icacal#	N	2.3 (2009, 2012, 2016)	-88.015986°	13.165526°	9.4	100.0	16	2	B
Punta Amapala#	Y	22.5 (2008-2009, 2012, 2014-2016)	-87.936131°	13.159791°	6.5	100.0	5,6,7,16	1	B
El Tamarindo#	N	0.4 (2009, 2012-2016)	-87.916344°	13.183208°	1.9	100.0	16	2	B
El Majahual (Isla Meanguera)#	N	2.5 (2009, 2016)	-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.

Convenciones Internacionales	Firmados	Convenio Vinculante	Cumplimiento medido e informado	Especies	Acciones de conservación	Relevancia para las tortugas marinas
Convention on Biological Diversity	Y	Y	Y	ALL	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	ALL	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. Organizations related with sea turtle research and conservation in El Salvador.

NGO	Primary species	Primary beaches	Long-term (>5 consecutive years)
ADEL LA UNION	*Lo*	El Icacal	N
ADESCOIM	*Lo*	Isla de Méndez	Y
AMBAS	*Lo*	Barra de Santiago	Y
Arenas del Pacífico	*Lo*	Las Bocanitas	N
ASIBAHIA	*Lo*	Isla San Sebastián	N
Asociación Mangle	*Lo*	Isla Montecristo, Ceiba Doblada	Y
ATOPLOCPC	*Lo*	Los Pinos/Cangrejera	Y
Ayuda en Acción	*Lo*	El Tular, Corral de Mulas	Y
CODEPA	*Lo*	Isla San Sebastián	N
Fundación Domenech	*Lo*	Costa del Sol	Y
FUNDARRECIFE	*Lo*	Los Cóbanos Reef Protected Area	Y
FUNDATAMARINDO	*Lo*	El Tamarindo	Y
FUNSALPRODESE	*Lo*	Icacal, El Majahual (Meanguera)	N
FUNZEL	*Lo*	Playa Dorada, San Blas, San Diego, El Amatal, Isla Tasajera	Y
FUTECMA	*Lo*	Los Pinos/Cangrejera	N
ICAPO/ProCosta	*Ei*	Bahía de Jiquilisco, Los Cóbanos Reef Protected Area, Punta Amapala	Y
Madre Cría	*Lo*	San Marcelino/Las Hojas	N
MSM	*Lo*	San Juan del Gozo	Y
Oikos	*Lo*	El Espino, Salamar	N
PROMESA	*Lo*	El Espino	Y
SalvaNatura	*Lo*	Costa del Sol	Y
VIVAZUL	*Lo*	El Amatal, Toluca, Salamar, El Icacal	N

Table 5. Minimum annual fishing effort and hawksbill bycatch in lobster gillnet fisheries at Los Cóbanos Reef Protected Area (LC, 2008-2009) and Punta Amapala (PA, 2012-2014) in El Salvador. Min. effort: minimum gillnet fishing effort; Bycatch, number of hawksbills captured in lobster gillnet fisheries. Modified from Table 3 in 14.

Site	Year	Observed			Estimated total		
		Boats	Min. effort	Bycatch	Boats	Min. effort	Bycatch
LC	2008	1	177.5	2	14	2485.0	27
	2009	1	710.7	1	14	9950.0	12
	Total	1	888.2	3	14	12,435.0	41
PA	2012	4	676.8	3	53	8967.0	40
	2013	4	5988.7	10	53	79,350.6	106
	2014	4	3181.5	1	53	42,154.9	12
	Total		9847.0	14	53	130,472.8	158
Overall		5	10,735.2	17	67	142,907.8	199

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

Figure 2. Marine areas in EL Salvador.

REFERENCES

1. Hasbún, C. R. & Vásquez, M. Sea turtles of El Salvador. Marine Turtle Newsletter 85, 7–9 (1999).

2. Vásquez, M., Liles, M. J., Lopez, W., Mariona, G. & Segovia, J. Sea turtle research and conservation in El Salvador. 45 (FUNZEL-ICMARES/UES, San Salvador, El Salvador, 2008).

3. Vásquez, M. & Liles, M. J. Estado actual de las tortugas marinas en El Salvador. Mesoamericana 12, 53 (2008).

4. Gaos, A. R. et al. Signs of hope in the eastern Pacific: international collaboration reveals encouraging status for a severely depleted population of hawksbill turtles Eretmochelys imbricata. Oryx 44, 595–601, doi:10.1017/s0030605310000773 (2010)

5. Liles, M. J. et al. Hawksbill turtles Eretmochelys imbricata in El Salvador: nesting distribution and mortality at the largest remaining nesting aggregation in the eastern Pacific Ocean. Endang. Species Res. 14, 23–30 (2011).

6. Liles, M. J. et al. One size does not fit all: importance of adjusting conservation practices for endangered hawksbill turtles to address local nesting habitat needs in the eastern Pacific Ocean. Biological Conservation 184, 405–413 (2015).

7. Gaos, A. R. et al. Living on the edge: hawksbill turtle nesting and conservation along the eastern Pacific Rim. Latin American Journal of Aquatic Research 45, 572–584 (2017).

8. de Paz, C. & Sui, S. Observadores abordo. 58 pp. (CENDEPESCA–WWF, San Salvador, El Salvador, 2008).

9. Liles, M. J. & Thomas, C. Sea turtle priority conservation areas in the coastal waters of El Salvador. 45 pp. (USAID, San Salvador, 2010).

10. Arauz, R. A description of the Central American shrimp fisheries with estimates of incidental capture and mortality of sea turtles. In: Proceedings of the 15th Annual Symposium on Sea Turtle Biology and Conservation, Hilton Head, South Carolina, 5–9 (1996).

11. Meza Ruíz, T. L. et al. Identificación macroscópica y calidad nutricional del contenido esofágico de la tortuga prieta Chelonia mydas agassizzi (Bocourt, 1868) en Usulután, El Salvador. Bioma 37, 32–49 (2015).

12. Gaos, A. R. et al. Shifting the life-history paradigm: discovery of novel habitat use by hawksbill turtles. Biology Letters 8, 54-56, doi:10.1098/rsbl.2011.0603 (2012).

13. Gaos, A. R. et al. Spatial ecology of critically endangered hawksbill turtles Eretmochelys imbricata: implications for management and conservation. Mar. Ecol. Prog. Ser. 450, 181–194, doi:10.3354/meps09591 (2012).

14. Liles, M. J. et al. Survival on the rocks: high bycatch in lobster gillnet fisheries threatens hawksbill turtles on rocky reefs along the Eastern Pacific coast of Central America. Latin American Journal of Aquatic Research 45, 521–539 (2017).

15. Rivas, S. Hábitos alimentarios de la tortuga carey (Eretmochelys imbricata) en la Reserva de Biósfera Bahía de Jiquilisco, Usulután, El Salvador, University of El Salvador, (2017).

16. Red Xiultic. Anidaciónes de tortugas marinas en El Salvador, 2009-2016. (Primer Simposio de Tortugas Marinas, San Salvador, El Salvador, 2017).

17. Herrera Serrano, N. O. Estado de conservación de la tortuga baule (Dermochelys coriacea) en El Salvador. Revista Comunicaciones Científicas y Tecnológicas 2, 72–80 (2016).

18. Urteaga, J. et al. Estado de conservacion de tortugas carey en el golfo de Fonseca. (ICAPO-USAID, 2014).

19. Gaos, A. R. et al. Prevelence of polgymy in a critically endangered marine turtle population. Journal of Experimental Marine Biology and Ecology (In revision).

20. Gaos, A. R. et al. Hawksbill turtle terra incognita: conservation genetics of eastern Pacific rookeries. Ecology and Evolution 6, 1251–1264 (2016).

21. Gaos, A. R. et al. Natal foraging philopatry in eastern Pacific hawksbill turtles. Royal Society Open Science, DOI: 10.1098/rsos.170153 (2017).

22. Gaos, A. R. et al. Rookery contributions, movements and conservation needs of hawksbill turtles at foraging grounds in the eastern Pacific Ocean using mtDNA markes. Marine Ecology Progress Series (In revision).

23. Gaos, A. R. et al. Dive behaviour of adult hawksbills (Eretmochelys imbricata, Linnaeus 1766) in the eastern Pacific Ocean highlights shallow depth use by the species. J. Exp. Mar. Biol. Ecol. 432, 171–178, doi:10.1016/j.jembe.2012.07.006 (2012).

24. Liles, M. J. et al. Current status of sea turtle nesting beach habitat in El Salvador. pp. 76 (USAID, San Salvador, El Salvador, 2010).

25. Liles, M. J. et al. Connecting international conservation priorities with human wellbeing in low-income nations: lessons from hawksbill turtle conservation in El Salvador. Local Environment 20, 1383–1404 (2015).

26. Tauer, A. M. et al. Hematology, biochemistry, and toxicology of wild hawksbill turtles (Eretmochelys imbricata) nesting in mangrove estuaries in the eastern Pacific Ocean. PLoS ONE (Under review).

27. Ramírez, E. et al. Shoalgrass Halodule wrightii (Ascherson, 1868) meadows in El Salvador: distribution and associated macroinvertebrates at the estuary complex of Bahía de Jiquilisco. Latin American Journal of Aquatic Research 45, 864–869 (2017).

28. Amaya, O., Ruiz, G., Espinoza, J. & Rivera, W. Saxitoxin analyses with a receptor binding assay (RBA) suggest PSP intoxication of sea turtles in El Salvador. Harmful Algae News 48, 1–7 (2014).

29. República de El Salvador. Se establecen medidas de ordenación y conservación para la protección y desarrollo sostenible del recurso hidrobiológico Langosta (Panulirus gracilis). (Diario Oficial No. 7. Tomo No. 398, 11 Enero, 2013).

30. República de El Salvador. Se suspende temporalmente de la extracción del recurso camarón de mar en todos los estadíos de su vida, estableciendo una veda por un periodo de trenta días. (Diario Oficial No. 195. Tomo No. 417, 19 Octubre, 2017).

31. República de El Salvador. Se establece como área natural protegida, el Complejo Los Cóbanos. (Diario Oficial No. 29. Tomo No. 378, 12 Febrero, 2008).

32. MARN (Ministerio de Medio Ambiente y Recursos Naturales). Propuesta del plan de manejo actualizado para el periodo 2012–2017 del Área de Conservación Bahía de Jiquilisco. 162 pp. (MARN, San Salvador, El Salvador, 2013).

33. MARN (Ministerio de Medio Ambiente y Recursos Naturales). Estado actual de las areas naturales protegidas en El Salvador. 57 pp. (MARN, San Salvador, El Salvador, 2003).

CHAPTER 4 NICARAGUA

Updated 2019

Jose Urteaga[1], Velkiss Gadea[2,3,4,], Liza Gonzáles[5], Carlos Mejía[6], Heydi Salazar[2], Eduardo Altamirano[2], Alejandra Rivera[2]

[1]Stanford University, E-IPER, 55 Dudley ln apt 104, Stanford CA 94305, U.S.A.
[2]Fauna & Flora Intenational, Calle Esperanza. Casa No. 578, Managua, Nicaragua
[3]Eastern Pacific Leatherback Network, Laúd OPO
[4]Iniciativa Carey del Pacífico Oriental, ICAPO
[5]Paso Pacifico, Carretera a Masaya Km 12.4. Recidencial Villas del Prado, Casa No. 7, Managua, Nicaragua
[6]Ministerio del Ambiente y los Recursos Naturales (MARENA), Carretera Norte Km. 12 1/2, Frente a Corporacion Zona Franca, Managua, Nicaragua

Table 1. Main biology and conservation aspects of sea turtles in the Nicaraguan Pacific.

RMU	Lo	Ref #	Dc	Ref #	Cm	Ref #	Ei	Ref #
Occurrence								
Nesting sites	Y	21	Y	21	Y	21	Y	21
Pelagic foraging grounds	n/a		n/a				n/a	
Benthic foraging grounds	n/a		n/a				JA	15,20
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	n/a				n/a		n/a	
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	n/a		n/a		n/a		n/a	
Nests / female season (N)	n/a		n/a		n/a		n/a	
Female remigration interval (yrs) (N)	n/a		n/a		n/a		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	
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)	n/a		n/a		n/a		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
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)	42, PS	Down (2002-2017)	25	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)	n/a		n/a		n/a		n/a	
Published studies								
Growth rates	N		N		N		N	
Genetics	N		N		N		Y	14,18
Stocks defined by genetic markers	N		N		N		Y	18, 48
Remote tracking (satellite or other)	N		N		Y	26	Y	15
Survival rates	N		N		N		N	
Population dynamics	N		N		N		Y	17
Foraging ecology (diet or isotopes)	N		N		N		Y	Unpublished
Capture-Mark-Recapture	N		N		N		Y	17
Threats								
Bycatch: presence of small scale / artisanal fisheries?	Y	22	Y	22, 25	Y	22	Y	20
Bycatch: presence of industrial fisheries?	N		N	22	N		N	
Bycatch: quantified?	N		N	22	N		Y	20
Take. Intentional killing or exploitation of turtles	Y	22	n/a		n/a		N	
Take. Egg poaching	Y	22	Y	22, 25	Y	22, 27	Y	Table 2
Coastal Development. Nesting habitat degradation	Y	22	Y	22, 25	n/a		n/a	
Coastal Development. Photopollution	n/a		n/a		n/a		n/a	
Coastal Development. Boat strikes	n/a		n/a		n/a		n/a	
Egg predation	Y	22	N		n/a		n/a	
Pollution (debris, chemical)	n/a		n/a		n/a		n/a	
Pathogens	n/a		n/a		n/a		n/a	

Climate change	n/a		n/a		n/a		n/a	
Foraging habitat degradation	n/a		n/a		n/a		n/a	
Other			n/a		n/a		n/a	
Long-term projects								
Monitoring at nesting sites	Y	22	Y	22, 25	Y	22,27	Y	8
Number of index nesting sites	2	PS	2	22, 25	2	27	2	8, 32
Monitoring at foraging sites	N		N		N		Y	unpublished
Conservation								
Protection under national law	Y	22	Y	22	Y	22	Y	22
Number of protected nesting sites (habitat preservation)	5	See text	2	22	4	22, 27, 41	1	27, 32
Number of Marine Areas with mitigation of threats	n/a		n/a		n/a		1	27, 32
Long-term conservation projects (number)	5	See text	1	25	1		2	27, 32
In-situ nest protection (eg cages)	Y		N		Y	27	Y	8, 27, 32
Hatcheries	Y		Y		Y	27, 41	Y	8, 27, 32
Head-starting	n/a		N		N		N	
By-catch: fishing gear modifications (eg, TED, circle hooks)	Y	22	Y	22	Y	22	Y	22
By-catch: onboard best practices	Y		N	n/a	N		Y	20
By-catch: spatio-temporal closures/reduction	Y	22	Y	22	Y	22	Y	22
Other	n/a		n/a		n/a		n/a	

Table 2. Sea turtle nesting beaches in the Nicaraguan Pacific.

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 success /season	Average Monitoring season (Start date - En date)	renesting (clotches/female) Range-seanon	remigration (Yrs)
Lo				Long	Lat												
Ostional*	N	73.5 (2014-2015)	n/a	-85.76010179	11.10619335	1.5	n/a	27	2							n/a	n/a
Guacalito	N	0.5 (2014-2015)	n/a	-85.78023317	11.11680168	0.3	100	27	1	B					Ene-Dic	n/a	n/a
Holman	N	2 (2012-2013)	n/a	-85.79125555	11.12199507	0.8	100	26	1	B					Jun-Jan	n/a	n/a
La Flor	Y	136014 (2011-2016)	n/a	-85.79411084	11.14119138	1	100	21, 24	1	B	n/a	n/a	95	6.3	(1-July/ 31-Jan)	n/a	n/a
Brasilon	N	21.3 (2013-2015)	n/a	-85.79988094	11.14889052	0.35	100	27	1	B	87				Ene-Dic	n/a	n/a
El Coco*	N	173.5 (2014-2015)	n/a	-85.80223115	11.15655136	0.8	n/a	27	2							n/a	n/a
Escondida	N	28.7 (2013-2015)	n/a	-86.12224065	11.46853317	0.5	100	27	1	B				76.3	Ene-Dic	n/a	n/a
Redonda	N	16 (2015)	23 (2015)	-86.03087102	11.38316457	0.3	100	27	1	B					Ene-Dic	n/a	n/a
Chacocente	Y	57408 (2011	n/a	-86.18570537	11.52476736	1.5	100	21, 24	1	B	n/a	n/a	95	16	(1-July/ 31-Jan)	n/a	n/a

		- 2016)															
Veracruz de Acayo	N	267 (2010 - 2016)	326 (2010-2016)	-86.25083333	11.57722222	5.5	100	4, 25, 35-39	2	D	23.3	57.9	86	68.57	(28-Oct / 23-March)	n/a	n/a
Salamina	N	376 (2010 - 2016)	387 (2010-2012; 2016)	-86.65361111	11.9775	9	100	10-13,19,33,34	2		25.7	56.3	87.1	73.14	(24-Oct/1-Apr)	n/a	n/a
Juan Venado	N	530 (2008)	n/a	-86.94422071	12.30900206	22	100	42	2							n/a	n/a
Estero Padre Ramos	Y	19.5 (2012 - 2017)	20.14 (2012-2017)	-87.48443559	12.77513888	12	100	1, 5-8, 41	2		84.62	62.9	85	84.65	(2-May/30-Sep)	n/a	n/a
Dc																	
El Coco*	N	1.5 (2014 - 2015)	n/a	-85.80207474	11.15681255	0.8	n/a	27	2				64	13			
Veracruz de Acayo	Y	9.7 (2010 - 2016)	10.5 (2010-2016)	-85.80223115	11.15655136	5.5	100	4, 25, 35-39	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)	-86.65361111	11.9775	9	100	10-13,19,33,34	1	B	94	132.8	58.5	31	(24-Oct/1-Apr)	8 to 12	2
Juan Venado	N	11 (2008)	n/a	-86.94422071	12.30900206	22	100	42	1	B					(25-Jul/31-jan)		
Cm																	
Ostional*	N	5 (2014 - 2015)	n/a	-85.76010179	11.10619335	1.5	n/a	27	2								
Guacalito	Y	16.5 (2014 - 2015)	n/a	-85.78023317	11.11680168	0.3	100	27	1	B	93.9				Ene-Dic		
Holman	N	1 (2012 - 2013)	n/a	-85.79125555	11.12199507	0.8	100	26	1	B							

Brasilon	Y	108 (2013-2015)	n/a	-85.79988094	11.14889052	0.35	100	27	1	B	87				Ene-Dic		
El Coco*	N	29.5 (2014-2015)	n/a	-85.80223115	11.15655136	0.8	n/a	27	2								
Escondida	Y	74.3 (2013-2015)	n/a	-86.12224065	11.46853317	0.5	100	27	1	B				75	Ene-Dic		
Redonda	N	23 (2015)	26 (2015)	-86.03087102	11.38316457	0.3	100	27	1	B					Ene-Dic		
Veracruz de Acayo	N	13.4 (2010-2016)	20.9 (2010-2016)	-86.25083333	11.57722222	5.5	100	4, 25, 35-39	1	B	90.4	86	71	63.52	(28-Oct / 23-March)	NA	NA
Salamina	N	3.5 (2010-2016)	3.5 (2010-2016)	-86.65361111	11.9775	9	100	10-13,19,33,34	1	B	100	72.5	75.7	61.49	(24-Oct/1-Apr)	NA	NA
Juan Venado	N	4 (2008)	n/a	-86.94422071	12.30900206	22	100	42	1	D							
Aserradores	N	8 (2014-2017)	15.7 (2014-2017)	-87.34361111	12.61583333	4.5	100	29-32	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)	-87.48443559	12.77513888	12	100	1, 5-8, 41	2		79.5	79.5	81	71.06	(2-May/30-Sep)	NA	NA
Ei																	
Ostional*	N	5 (2014-2015)	n/a	-85.76010179	11.10619335	1.5		1	2								
Guacalito	N	1.5 (2014-2015)	n/a	-85.78023317	11.11680168	0.3	100	1	1	B	75				Ene-Dic		
Holman	N	1 (2012-2013)	n/a	-85.79125555	11.12199507	0.8	100	26	1	D							

Brasilon	N	0.67 (2013-2015)	n/a	-85.79984093	11.14867741	0.35	100	1	1	B	87				Ene-Dic		
El Coco*	N	3.5 (2014-2015)	n/a	-85.80207474	11.15681255	0.8	100	1	2				149.4	36.3			
Escondida	N	2 (2013-2015)	n/a	-86.12224065	11.46853317	0.5	100	1	1	B				75.00	Ene-Dic		
Redonda	N	8 (2015)	9 (2015)	-86.03087102	11.38316457	0.3	100	1	1	B					Ene-Dic		
Juan Venado	N	1 (2008)	n/a	-86.94422071	12.30900206	22	100	42	1	D							
Aserradores	Y	70 (2014-2017)	127.3 (2014-2017)	-87.34361111	12.61583333	4.5	100	29-32	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)	-87.48443559	12.77513888	12	100	1, 5-8, 41	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.

Binding	Compliance measured and reported	Species	Conservation actions	Relevance to sea turtles
-	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
Y	Yes	all	It restricts the international trade of sea turtle sub products.	
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	
	n/a	all	Nicaragua has not signed this convention	

Table 4. Organizations and agencies related with sea turtle research and conservation in Nicaragua.

Organization coordinating field work	Organization type	Primary species	Primary beaches	Long-term (>5 consecutive years)
MARENA	Gobernment	Lo	La Flor	Y
MARENA	Gobernment	Lo	Chacocente	Y
Paso Pacifico	NGO	Cm, Lo	Ostional	
Paso Pacifico	NGO	Lo	Guacalito	Y
Paso Pacifico	NGO	Lo	Holman	Y
Paso Pacifico	NGO	Cm	Brasilon	Y
Paso Pacifico/ Parque Maritimo El Coco	NGO / Private*	Lo, Cm	El Coco	Y
Paso Pacifico	NGO	Cm	Escondida	
Paso Pacifico	NGO	Cm	Redonda	
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	
Resort Mujul	Private	Lo	Guacalito de la Isla; Mansanillo	
Proyecto Cooperativa	Community/Private	Lo	Santana	
Hotel Punta Teonoste	Private	Lo	Punta Teonoste	Y
Gran Pacifica	Private	Lo	San Juan	Y
Rigo's House	Private	Lo	Salinas Grandes	
UNAN Leon	University	Lo, Dc	Salinas Grandes	Y
Proyecto Palo de Oro/ UNAN Leon / FFI	Private / Academic /NGO	Lo, Dc	Juan Venado	Y
Estreya del Pacifico		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	

Figure 1. Sea turtle nesting beaches in the Nicaraguan Pacific.

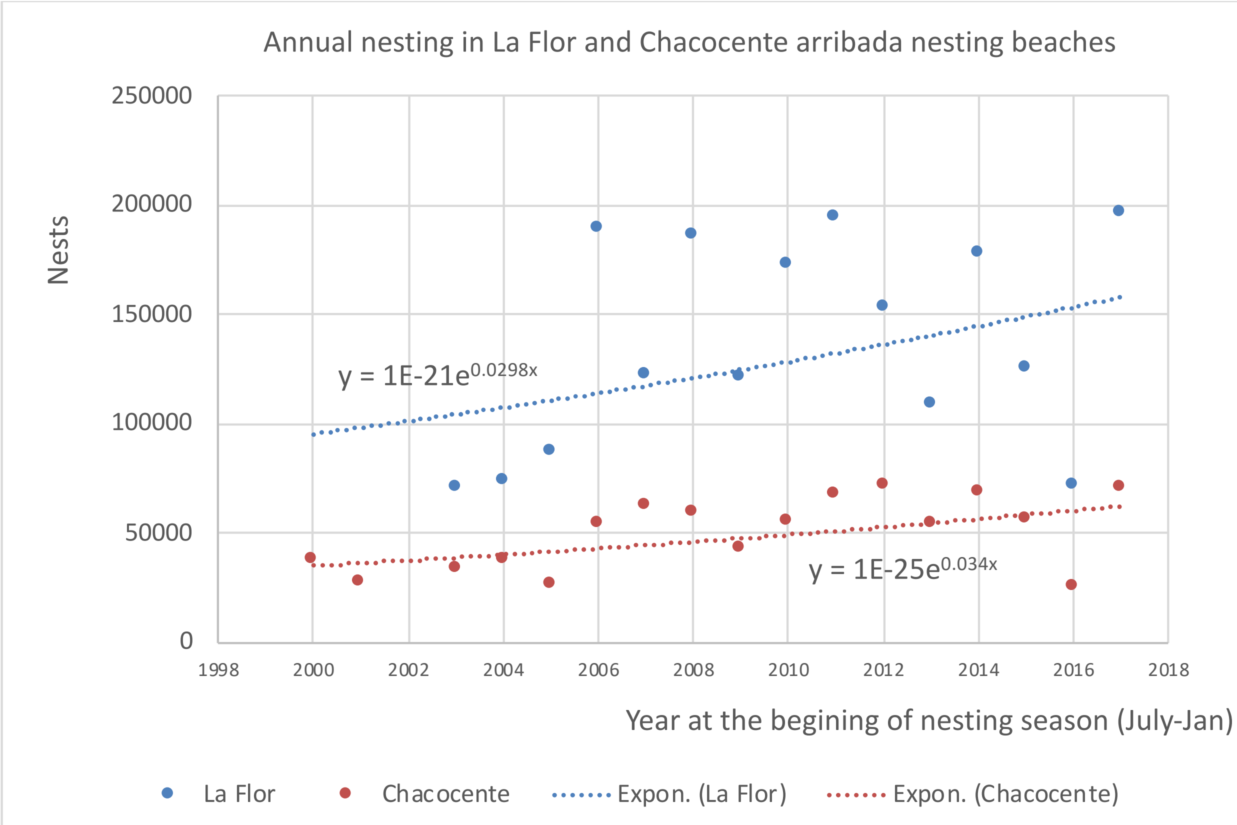


Figure 2. Annual nesting in La Flor and Chacocente arribada beaches.

REFERENCES

1 Altamirano Eduardo, Gadea Velkiss, Salazar Heydi. Informe del Proyecto de Conservación de tortuga Carey (Eretmochelys imbricata) en la Reserva Natural Estero Padre Ramos, Nicaragua. Programa de Tortugas Marinas-Fauna & Flora International e ICAPO: 2016. 2017.

4 Altamirano, E. y Torres, P. Informe del Proyecto de Conservación de Tortuga Tora (D. coriacea) en la Playa de Acayo-Mogote, RVS Chacocente. Programa de Conservación de Tortugas Marinas. Fauna & Flora International: 2010-2011. 2011.

5 Altamirano, Eduardo, Torres, Perla y Abarca, Gena. Informe Final del Proyecto de Conservación de Tortuga Carey (Eretmochelys imbricata) en la RN Estero Padre Ramos. Programa de Tortugas Marinas-Fauna & Flora International e ICAPO. 42 pp: 2010. 2011.

6 Altamirano, Eduardo. Informe del Proyecto de Conservación de tortuga carey (Eretmochelys imbricata) en la RN Estero Padre Ramos, Nicaragua. Programa de Tortugas Marinas-Fauna & Flora International e ICAPO: 2013. 2014.

7 Altamirano, Eduardo. Informe del Proyecto de Conservación de tortuga Carey (Eretmochelys imbricata) en la RN Estero Padre Ramos, Nicaragua. Programa de Tortugas Marinas-Fauna & Flora International e ICAPO: 2014. 2015.

8 Altamirano, Eduardo. Informe del Proyecto de Conservación de tortuga Carey (Eretmochelys imbricata) en la RN Estero Padre Ramos, Nicaragua. Programa de Tortugas Marinas-Fauna & Flora International e ICAPO: 2015. 2016.

9 Anne Sitton. Los Cardones Ecologed - temporada 2011 al 2016: unpublished data.

3 Chacon, Didiher. Synopsis of the Leatherback Sea Turtles (Dermochelys coreacea). Inter-American Convention for the Protection and Conservation of Sea Turtles. INF-16-04. 27 pp. URLS: http://www.iacseaturtle.org/eng-docs/publicaciones/INF-16-04-eng.pdf

10 Gaitán P. Ofelia y Mojica, Javier . Informe Proyecto Conservación de Tortuga Tora (D. coriacea) en Playa Salamina y Costa Grande. Programa de Conservación de Tortugas Marinas. Fauna & Flora International: 2012-2013. 2013.

11 Gaitán P. Ofelia y Mojica, Javier . Informe Proyecto Conservación de Tortuga Tora (D. coriacea) en Playa Salamina y Costa Grande. Programa de Conservación de Tortugas Marinas. Fauna & Flora International: 2013-2014. 2014.

12 Gaitán P. Ofelia y Mojica, Javier . Informe Proyecto Conservación de Tortuga Tora (D. coriacea) en Playa Salamina y Costa Grande. Programa de Conservación de Tortugas Marinas. Fauna & Flora International: 2014-2015. 2015.

13 Gaitán P. Ofelia y Mojica, Javier . Informe Proyecto Conservación de Tortuga Tora (D. coriacea) en Playa Salamina y Costa Grande. Programa de Conservación de Tortugas Marinas. Fauna & Flora International: 2015-2016. 2016.

14 Gaos AR, Lewison RL, Jensen MP, Liles MJ, Chavarria S, Mario C, et al. Natal foraging philopatry in eastern Pacific hawksbill turtles. Royal Society Open Science 4: 170153. 2017

15 Gaos AR, Lewison RL, Wallace BP, Yanez IL, Liles MJ, Nichols WJ, et al. Spatial ecology of critically endangered hawksbill turtles Eretmochelys imbricata: implications for management and conservation. Mar Ecol Prog Ser. 2012; 450:181-U198.

17 Gaos AR, Liles MJ, Gadea V, Niz AP De, American L, Turtles S, et al. Living on the Edge : Hawksbill turtle nesting and conservation along the Eastern Pacific Rim. LAJAR. 2017;45(3):572–84.

18 Gaos AR., Lewison RL., Liles MJ., Gadea V, Altamirano E, Henriquez AV., et al. Hawksbill turtle terra incognita: Conservation genetics of eastern Pacific rookeries. Ecol Evol. 2016;6(4):1251–64.

19 Jarquín, Lídice; Mojica, Javier; Salazar, Heydi y Gadea, Velkiss. Informe final del proyecto de conservación de tortugas Toras (Dermochelys Coriacea) en Playa Salaminas y Costa Grande. Programa de Conservación de Tortugas Marinas. Fauna & Flora International: 2016-2017. 2017.

20 Liles MJ, Gaos AR, Bolaños AD, Lopez WA, Arauz R, Gadea V, et al. Survival on the rocks : high bycatch in lobster gillnet fisheries threatens hawksbill turtles on rocky reefs along the Eastern Pacific coast of Central America. LAJAR. 2017;45(3):521–39.

21 MARENA. Chacocente and La Flor Arribadas Monitoring. Unpublished data (2011-2016). Managua; 2017.

22 MARENA. Estrategia para La Conservación de Tortugas Marinas en el Pacífico de Nicaragua. Managua: Fauna & Flora International; 2006. 87 p. URL: http://www.tortugasnicas.org/media/materiales/documents/32.pdf

23 MARENA. Protocolo para el monitoreo de Playas de Arribada en el Pacifico de Nicaragua (2006-2007). Managua; 2007.

2 Morales, José. Análisis de la biología reproductiva de la tortuga tora, Demochelyscoriacea, en la estación biológica de Chacocente del Pacífico de Nicaragua. Documento Servicios de Parques Nacionales y Fauna Silvestre. Instituto Nicaragüense de Recursos Naturales y del Ambiente (IRENA). 1983.

24 Orrego CM. Biology and Management of Olive Ridley Turtles (Lepidochelys olivacea) in Central America. Drexel University; 2014.

25 Padilla, D, Salazar, H y Gadea, V. Informe del Proyecto de Conservación de Tortuga Tora (D. coriacea) en la Playa de Acayo-Mogote, RVS Chacocente. Programa de Conservación de Tortugas Marinas. Fauna & Flora International: 2016-2017. 2017.

26 Paso Pacifico. Reporte Final Telemetría Satelital de Tortugas Marinas en las Playas del Corredor Biológico Paso del Istmo DGPN/DB – IC – 012 – 2012. Managua; 2012.

27 Peñalba M, Coronado J. Informe Técnico Programa de Monitoreo y Anidación de Tortugas Marinas en Playas Secundarias dentro y alrededor del Refugio de Vida Silvestre La Flor (2013-2015). Managua; 2016.

28 Pravia, Santos y Orozco Moises. Proyecto Palo de Oro: 2016-2017. unpublished data.

29 Rivera, Alejandra . Informe del Proyecto de Conservación de tortuga carey (Eretmochelys imbricata) en Aserradores, Nicaragua. Programa de Tortugas Marinas -Fauna & Flora International e ICAPO. 39 pp: 2015. 2016.

30 Rivera, Alejandra . Informe del Proyecto de Conservación de tortuga carey (Eretmochelys imbricata) en Aserradores, Nicaragua. Programa de Tortugas Marinas-Fauna & Flora International. 32 pp: 2014. 2015.

31 Rivera, Alejandra, Gadea Velkiss, Salazar Heydi. Informe del Proyecto de Conservación de tortuga carey (Eretmochelys Imbricata) en Aserradores, Nicaragua. Programa de Tortugas Marinas -Fauna & Flora International e ICAPO: 2017. In preparation.
32 Rivera, Alejandra, Gadea Velkiss, Salazar Heydi. Informe del Proyecto de Conservación de tortuga carey (Eretmochelys Imbricata) en Aserradores, Nicaragua. Programa de Tortugas Marinas -Fauna & Flora International e ICAPO. 44 pp: 2016. 2017.

33 Rodríguez B. Guillermo y Gaitán P. Ofelia. Informe Proyecto Conservación de Tortuga Tora (D. coriacea) en Playa Salamina y Costa Grande. Programa de Conservación de Tortugas Marinas. Fauna & Flora International: 2010-2011. 2011.

34 Rodríguez B. Guillermo y Gaitán P. Ofelia. Informe Proyecto Conservación de Tortuga Tora (D. coriacea) en Playa Salamina y Costa Grande. Programa de Conservación de Tortugas Marinas. Fauna & Flora International: 2011-2012. 2012.

35 Salazar, H y Gadea, V. Informe del Proyecto de Conservación de Tortuga Tora (D. coriacea) en la Playa de Acayo-Mogote, RVS Chacocente. Programa de Conservación de Tortugas Marinas. Fauna & Flora International: 2014-2015. 2015.

36 Salazar, H y Gadea, V. Informe del Proyecto de Conservación de Tortuga Tora (D. coriacea) en la Playa de Veracruz de Acayo, RVS Chacocente. Programa de Conservación de Tortugas Marinas. Fauna & Flora International: 2015-2016. 2016.

37 Salazar, H y Gadea, V.. Informe del Proyecto de Conservación de Tortuga Tora (D. coriacea) en la Playa de Acayo-Mogote, RVS Chacocente. Programa de Conservación de Tortugas Marinas. Fauna & Flora International: 2013-2014. 2014.

38 Salazar, H y Torres, P. Informe del Proyecto de Conservación de Tortuga Tora (D. coriacea) en la Playa de Acayo-Mogote, RVS Chacocente. Programa de Conservación de Tortugas Marinas. Fauna & Flora International: 2011-2012. 2012.

39 Salazar, H y Torres, P. Informe del Proyecto de Conservación de Tortuga Tora (D. coriacea) en la Playa de Acayo-Mogote, RVS Chacocente. Programa de Conservación de Tortugas Marinas. Fauna & Flora International: 2012-2013. 2013.

40 Sampson Enrique. Conservación de Tortuga Tora (Dermochelys coriacea) en la Reserva Natural Estero e Isla Juan Venado. UNAN-León, Fauna & Flora International: 2010-2011. unpublished data.

41 Torres, P. y Altamirano, E. Informe del Proyecto de Conservación de tortuga carey (Eretmochelys imbricata) en la RN Estero Padre Ramos, Nicaragua. Programa de Tortugas Marinas-Fauna & Flora International e ICAPO: 2012. 2013.

42 Torres, P., J. Urteaga. Consolidado de Monitoreo de Tortugas Marinas en el Pacífico de Nicaragua: Temporada 2008-09. Informe Tecnico. MARENA. 2009. pp 32 URL: http://www.tortugasnicas.org/media/materiales/documents/18.pdf
43 https://www.cbd.int/doc/world/ni/ni-nr-05-es.pdf

44 Salazar, Maynor. 2015. Diagnóstico sobre la situación actual de la pesca con bombas en las aguas del Pacífico de Nicaragua. Programa Marino - Fauna & Flora International. 36 pág.

45 Gadea, Velkiss E.; Segura, Álvaro; Urteaga, José; Hall, Martin A.; Vogel, Nick. 2011. Sea turtle by catch in the long line fisheries in the Nicaraguan Pacific: A preliminary analysis on the effect of different hooks. Fauna & Flora Internacional, Inter American Tropical Tuna Commission, NOAA.

46 Gadea, Velkiss E. et. al. Registro de Captura Incidental de tortugas marinas en el Pacífico de Nicaragua. In preparation.

47 Gadea, Velkiss E. et al. Registro de Varamiento de tortugas marinas en el Pacífico de Nicaragua. In preparation.

48 Gaos AR, Lewison RL, Jensen MP, Liles MJ, Henriquez A, Chavarria S, et al. Rookery contributions , movements and conservation needs of hawksbill turtles at foraging grounds in the eastern Pacific Ocean. Mar Ecol Prog Ser. 2018;586:203–16.

49 Chan EH, Liew HC. Incubation temperatures and sex-ratios in the Malaysian leatherback turtle Dermochelys coriacea. Biological conservation. 1995 Jan 1;74(3):169-74.

CHAPTER 5 COSTA RICA

Updated 2019

Rotney Piedra-Chacón[1], Elizabeth Vélez-Carballo[2], Didiher Chacón-Chaverri[3,7], Pilar Santidrián-Tomillo[4], Mónica Espinoza -Miralles[5], Maike Heidemeyer[6], Luis Fonseca- López[7], Greivin Fallas[8], Isabel Naranjo[9], Carlos Mario Orrego[10], Valerie Guthrie[11], Nancy Tankersley[12], Frank Paladino[4] and Christian Diaz-Chuquisengo[4]

[1.] Sistema Nacional de Áreas de Conservación, Playa Grande, Santa Cruz, Guanacaste.
[2.] Asociación Kuemar, Los Ángeles de San Rafael, Heredia.
[3.] Wider Caribbean Sea Turtle Conservation Network (WIDECAST), Pacuare, Limón.
[4.] The Leatherback Trust, Playa Grande, Santa Cruz, Guanacaste.
[5.] Osa Conservation, Puerto Jiménez, Puntarenas.
[6.] Universidad de Costa Rica, San Pedro, San José.
[7.] Latin American Sea Turtle (LAST), Tibás, San José
[8.] Asociación de Voluntarios para el Servicio en Áreas Protegidas (ASVO), Barrio Amón, Ave. 11 y 13 Calle 1, San José.
[9.] Centro de Rescate de Especies Marinas Amenazadas (CREMA), Tibas, San José.
[10.] Ministerio de Ambiente y Energía, San José.
[11.] Asociación Vida Verdiazul, Playa Junquillal, Santa Cruz, Guanacaste.
[12.] Sea Turtles Forever, Los Pargos, Santa Cruz, Guanacaste.

General remarks

Costa Rica has been making an important effort in terms of improving its ecological representativeness, and precisely one of the conservation objects due to its hazards are 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*). Nesting loggerhead turtles (*Caretta caretta*) have been reported on Caribbean beaches, but it 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 the field of 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 and 1b).

In 2018, Costa Rica formalized its National Strategy for the Conservation and Protection of Sea Turtles, with the objective of improving the management over the following 10 years. Its vision is focused on developing management within and outside protected wilderness 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 (MINAE 2018).

In Costa Rica, non-governmental and academic organizations, as well as government institutions, make major contributions each year investing time and resources to investigate and protect sea turtles that arrive to 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 being developed along the coast of Costa Rica (see Table 4). Research and conservation of sea turtles has not only increased our knowledge about the biology of turtles over time, but has also provided scientists with 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 of the four species of sea turtles that are present 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. This has allowed the Costa Rican State, through the National System of Conservation Areas (SINAC) of the Ministry of Environment and Energy (MINAE), to register for the Pacific side of Costa Rica, at least 68 nesting sites for sea turtles (Fig. 2) and several foraging sites (Fig. 5 and Fig. 9). Of those 68 sites, 41.2% (n = 28) are within Protected Wildlife Areas (ASP, acronym in Spanish) and 58.8% (n = 40) outside Protected Wildlife Areas (FASP, acronym in Spanish).

The information that has been used to prepare this report corresponds only to data available for 33 nesting beaches where consolidated monitoring programs have been implemented. This group included index beaches by species and according to what has been reported to the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC) (MINAE-SINAC, 2018).

1. RMU *Dermochelys coriacea*, Eastern Pacific Ocean (DC-EPO)

1.1. Distribution, abundance, trends

1.1.1. Nesting sites

Along the Pacific coast of Costa Rica, nowadays 15 sites have been reported in which leatherback turtle nesting occurs (Fig. 3), 9 of them are in protected wildlife areas and 6 sites are outside protected wildlife areas. For the purposes of this report, the information was compiled for 9 of these sites, which have been permanently monitored over a determined period of years (see Table 2).

The greatest conservation efforts for the species in the country have been concentrated mainly on the beaches of Parque Nacional Marino Las Baulas (PNMB), 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. 4) (Santidrian-Tomillo et. al., 2007; Santidrian-Tomillo et. al., 2017a; Piedra et. al., 2007).

In the other 12 sites, leatherback nestings have also been reported, however, and according to Santidrian-Tomillo et. al. (2017a), four 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 seems to be an important secondary beach for leatherback turtles, according to the information compiled in this report.

Table 2 shows the information of the beaches Grande, Ventanas and Langosta, as one and refered 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-Zapotillal.

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.

Leatherback turtles in the Eastern Pacific have declined drastically during the last two decades, as indicated by the trends in number of nesting females and nests in the beaches of PNMB (Fig. 4). Steyermark et. al. (1996), Chaves et. al. (1996), Reina et. al. (2002) and Piedra et. al. (2007), in their works described important 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 9 nesting sites included in this report, for the period comprised between 2014-2018, an amount of 206 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, so it is very important and critical to maintain a permanent presence on the index beaches. Due to the critical state of the population, it is also necessary to maintain the effort in all those beaches that have been classified as secondary. Secondary beaches are considered as 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 (Santidrian-Tomillo et. al., 2017a). The information collected will continue to be relevant to generate important estimates of population trends.

1.1.2. 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 Km^2 (Fig 5).

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 6) (Morreale et. al., 1996; Shillinger et. al., 2008, 2011 and Bailey et. al., 2012). 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 (Shillinger et. al., 2011).

1.2. Other biological data

Table 1. shows a summary of important biological data for the specie in the Pacific side of Costa Rica.

1.3. 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:

1.3.1. Nesting sites

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 (Santidrian-Tomillo et. al., 2008). 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 human presence on the nesting beaches. If there is no presence related to conservation, the threat of egg poaching is still high.

Coastal development without control continues to be a threat, especially when the design of developmental projects that are adjacent 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, presence of vegetation is important, as well as lack of infrastructure in the areas adjoining the nesting habitats.

Marine protected areas of Costa Rica must have management plans, which defines 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 Secretaría Técnica Nacional Ambiental (National Environmental Technical Secretariat, a.k.a. Setena), 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 its subsequent operation of the project 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 effectively reduce the impact of development on nesting habitats, but there 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 is expected to decline due to climate change by the end of the 21st century (Santidrián-Tomillo et. al., 2012). In a follow-up study Saba et. al. (2012), projected that the population of leatherback turtles that nest at PNMB will decrease at a rate of 7% 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 (Santidrián-Tomillo et. al., 2017b) and makes it essential to consider the impacts of climate change in their recovery plans.

Costa Rica, in the framework of the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC), 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 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, and that 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. Marine areas

Sea turtles are long-lived organisms with delayed sexual maturity and high fecundity and that require high survival rates to keep their populations viable. Unfortunately, the population that nests in 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 (Santidrian-Tomillo et. al., 2017b).

In general, bycatch data are provided by observers on board or from reports in log books. 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) mention 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. 6). Although they predicted that 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 reproductive frequency of EP leatherbacks, most likely as a result of its impact on prey abundance in the southeast Pacific (Saba et. al., 2007). During the La Niña periods, the ocean surface temperature is lower, so there is a higher primary production and the turtles take less 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 (Saba et. al., 2007; Reina et. al., 2009)

1.4. Conservation

As mentioned in section 1.1.1, on the Pacific coast of Costa Rica there have been 15 beaches where leatherback turtle nesting has been reported (Fig. 3), 9 of these sites are under some category of State protection as National Wildlife Refuges or National Parks. In 6 of these sites there are long-term monitoring programs, with information available and that was facilitated to prepare this report (see Table 2). Twelve areas were been created for marine conservation and are under the administration of SINAC, and ten are marine areas of responsible fishing under the administration of the National Fisheries Institute. The leatherbacks of the Eastern Pacific could eventually move through these spaces (Fig. 1a and 1b).

The country has ratified 9 international treaties (see Table 3) and at least 30 national legal instruments (MINAE-SINAC 2018), 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 that are found 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 that are 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 it is ensured to continue with the generation of information, but at the same time, with human presence on the nesting beaches as permanent as possible. This has a significant impact on reducing egg poaching and preventing other possible threats. Table 4 lists the NGOs and State institutions that have been related to the management, conservation and research of sea turtles in the country.

Conservation priorities

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

1. Creation and implementation of a National Program for the Conservation of Sea Turtles as a mechanism to follow up and manage the provisions of national legislation, international agreements and the National Strategy for the Conservation and Protection of Sea Turtles.

2. Conformation of an Interinstitutional Advisory Group on marine turtles, to provide technical criteria and recommendations to the State authorities and the National Program for the Conservation of Sea Turtles.

3. Definition, officialization and implementation of governance models that help the sustainable management of sea turtle critical habitats.

4. Evaluation of the interaction of sea turtles 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 the collection of 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 carried out and the registered information of standardized monitoring indicators are systematized.

8. Monitoring of traffic and illegal trade of sea turtle products and byproducts.

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 (Figure 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. Standardization of a format to report bycatch.

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.

1.5. Research

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.

Promote research techniques to reduce incidental capture of sea turtles.

Marine debris impacts on sea turtles (including ingestion of plastics, ghost gear, microplastics) Impacts of climate change on sea turtle nesting and on its critical habitats.

2. RMU *Chelonia mydas*, Eastern Pacific Ocean (CM-EPO)

2.1. Distribution, abundance, trends

2.1.1. Nesting sites

Along the Pacific coast of Costa Rica, nowadays 41 sites have been reported in which black turtle nesting occurs (Fig. 7), 18 of them are in protected wildlife areas and 23 sites are outside of protected wildlife areas. For the purposes of this report, the information was compiled for 19 of these sites (25,2 Km beach lenght), which have been permanently monitored in the last years (see Table 1 and Table 2).

Table 2 shows the information of the beaches Nombre de Jesús and Zapotillal compiled into one. This because the analysis of nesting that occurs in these beaches independently can mislead and underestimate the dynamics of the population. The same happens with the Los Pargos beach complex. Reference is made to this detail because in table 2, in the sections "Number of" major "sites" and "Number of" minor "sites" the number of sites mentioned corresponds to 16 beaches.

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 from recent years that the importance of Costa Rican beaches for the nesting of the species is more consistently known and this is demonstrated by the published papers of Drake et. al. (2003), Blanco et. al. (2011 and 2012a), Santidrian-Tomillo et. al. (2014), Ureña López (2014), Dutton et. al. (2014) and Fonseca et. al. (2018). Monitoring and research programs have been consolidated over the years. This 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 on number of nests and number of nesting females that have been reported for three of the index beaches (Isla San José, Cabuyal and Nombre de Jesús) (Fig 8), position the North Pacific of Costa Rica as the most relevant nesting area for this species in the Central American isthmus (Chacon-Chaverri et. al., 2014a; CIT 2018). Even though the number of years of monitoring does not allow to determine a robust population trend of black turtle in Costa Rica, the attention and concern must be called when analyzing how the number of nests and females have been reducing in the last four years.

The population of black turtles in Costa Rica is recently monitored, however, it is very interesting and important for its conservation knowing that according to Dutton et. al. (2014), the population is genetically closely related to the population of Galápagos. He 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 of time. Thus, the recent nesting data observed in Figure 8 may be evidence of a change that should be considered for immediate attention and particularly when the numbers of nesting in Galapagos are declining (CIT 2018).

2.1.2. 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 due to the fact that 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 six important foraging areas have been identified for the black turtle in the Costa Rican Pacific, and in which the released information has been very relevant to consider into the conservation efforts that will be developed. These marine areas are: Golfo Dulce (Chacón-Chaverri et. al., 2014a) (Fig. 9a); Gulf of Papagayo (Blanco et. al., 2012b) (Fig. 9b): Santa Elena Bay (Blanco et. al., 2012b) (Fig. 9b);

adyacent Matapalito Bay and rather sporadic or stop-over sites such as Coyote and Cabo Blanco (Heidemeyer et. al., 2014; Heidemeyer et. a., 2018) (Fig. 9c).

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 (Chacón-Chaverri et. al., 2014a). Other relevant information is that turtles that were captured and tagged in the Gulf have not been reported yet on Costa Rican nesting beaches, not even found dead or incidentally captured; so, the origin of the individuals are not known (Chacón-Chaverri et. al., 2014a). 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 (Heidemeyer et al., 2014), including from the largest regional nesting rookery found in Colola, Mexico (Heidemeyer et al., 2018).

On the other hand, satellite information has shown that green turtles from Mexico and Galapagos migrate to foraging areas in Central America (Hart et. al., 2015) and, according to Dutton et. al. (2014), the Costa Rican population is product of multiple colonization paths from antient Central Pacific populations (Hawaii) and more recent immigrations from both the Galapagos and Mexian rookeries. In fact, green turtles tagged in Galapagos have been recorded nesting in beaches of the Costa Rican Pacific (Blanco et. al., 2012b), as well as foraging in Golfo Dulce (Chacón-Chaverrí et al. 2014a).

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 (Blanco et. al., 2012a) 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 (Blanco et. al., 2012b; Hart et. al., 2015).

Other interesting information to be considered is that in the other 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 (Heidemeyer et. al., 2014).

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, which corresponds to a population that remains resident near its nesting beach (Blanco et. al., 2012b).

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 (Blanco et. al., 2012b), where an interaction occurs between the individuals who congregate, even if they come from different places located at great distances.

2.2. Other biological data

Table 1 shows a summary of important biological data for the specie in the Costa Rican Pacific.

2.3. Threats

2.3.1. Nesting sites

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 wildlife areas. It has been estimated that, in the complex of Nombre de Jesús, one of the most important in the Pacific of Costa Rica (781 nests / year), egg extraction was more than 90% before 2006, year in which the monitoring program and research led by the organization Kuemar, entered the site more consistently. To this day, this percentage of extraction is estimated at 10% (unpublished data), since the presence of personnel is maintained most of the year and relocation of nests is made on the same beach. Despite this, the activity of egg poaching has not 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 are staff working on the beaches.

High visitation of tourists without 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 of protected areas, these prevention tools do not exist, and some tourist activities are carried out without applying good practices. For example, a large number of tourists around a turtle for the observation can cause a negative impact on them. Some just return to the sea, others even stop their egg-laying process.

The coastal development that does not include in its operation, risk analysis and impact mitigation measurements towards critical habitats for sea turtles, remains present as a threat that worries those responsible for the coordination of monitoring and research programs and to the SINAC. However, this concern requires to work on a 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 a 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, in the framework of the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC), has recognized that the effects of climate change impact the nesting and feeding habits of sea turtles, so in some of its index beaches the project called "Pilot Project for IAC Countries Parties for the collection of environmental parameters of their nesting index beaches" will be implemented for a continuous period of 5 years, based on the Resolution on the impacts of the Climate in the Sea Turtle habitats CIT-COP4-2009-R5 (http://www.iacseaturtle.org/docs/resoluciones COP4CIT/CIT-COP4-2009-R5ESP_Final.pdf).

2.3.2. Marine areas

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

2.4. Conservation

From the 41 sites where green turtles are reported, 18 of them are protected by some category of state management, National Wildlife Refuge or National Park. In 19 beaches there is a monitoring and research program of sea turtles, in which the protection of females and nests are carried out. Twelve are the areas that have been created for marine conservation and that are under the administration of SINAC and ten are the marine areas of responsible fishing, under the administration of the National Fisheries Institute. The green turtles could eventually move through these spaces (Fig.1a and 1b).

Other conservation details and priorities that all sea turtle species share can be seen in section 1.4. Table 4 shows a list of monitoring and research programs led by NGOs and state institutions.

2.5. Research

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.

Promote research techniques to reduce incidental capture of sea turtles.

Marine debris impacts on sea turtles (including ingestion of plastics, ghost gear, microplastics). Impacts of climate change on sea turtle nesting and on its critical habitats.

3. RMU: *Lepidochelys olivacea*, Eastern Pacific Ocean (LO-EPO)

3.1. Distribution, abundance, trends

3.1.1. Nesting sites

In the Pacific of Costa Rica, the nesting of *Lepidochelys olivacea* is reported in 65 beaches (Fig. 10), 27 of them are in protected wildlife areas and the remaining 38 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 the purposes of this report, information was compiled from 19 important sites (55.3 km of beach length), seven of them considered as 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 strategy. 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 (Bernardo and Plotkin 2007). Precisely in two of the Costa Rican beaches this behavior occurs, Ostional and Nancite.

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 a high mortality of density-dependent eggs, to which were added high concentrations of fungi and bacteria, as well as an important predation (Bernardo and Plotkin, 2007; Honarvar et. al., 2008; Fonseca et. al., 2009). 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 turtle eggs, however, in the case of Ostional, 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 egg collection is authorized by the State and is the only exception in Costa Rica within the framework of the CIT, according to Resolution CIT-COP7-2015-R1.

The sea turtle management and conservation project has created an adaptive action management model that contributes to the conservation of sea turtles, as well as the sustainable use of a sensitive natural resource such as Olive Ridley eggs. The

Ostional Wildlife Refuge has a management plan that operationalizes the project's actions for a period of five years. The Plan contains a regulatory framework with objectives, principles and rules on the governability and implementation of the plan, as well as actions aimed to the management and conservation of the habitat, sea turtles and their eggs. These rules were developed jointly by representatives of the community of Ostional through the Association of Integral Development (ADIO), the Costa Rican Fisheries Institute (INCOPESCA), the National System of Conservation Areas (SINAC) and the University of Costa Rica (UCR) (Orrego and Rodríguez, 2017). In addition, the wildlife refuge administration has the support of an Inter-Institutional Advisory Council and a permanent program of biological monitoring of Olive ridley population.

Even so the arribada in Ostional were 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 arribada show large intra and interannual fluctuations, so that a particular population trend could not be discerned. 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.

The attention of this species has been focused on arribada beaches. Nevertheless, solitary nesting sites are important and in many of them a monitoring and conservation program has been consolidated, such is the case of the beaches shown in Table 2. According to Dornfeld et. al. (2015), the turtles that nest in a solitary way make an important contribution to the Olive ridley population in the Tropical Eastern Pacific. For example, they found that solitary nesting beaches could be key sites for the birth of males since those laid nests between June to September (rainy season), in their study, were incubated under cooler temperatures than those recorded at arribada beaches, hatching successes were greater and, according to recent data presented in this report, emergency success was greater than that shown at the arribada beaches (see Table 1).

The Olive ridley sea turtle shows low fidelity to solitary nesting sites. This is proven with 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. So, those identified and reported beaches in this report should, as far as possible, be maintained under a monitoring and protection program for the nests.

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. 11). 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 was 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 data for the specie in the Costa Rican Pacific.

3.3. Threats

3.3.1. Nesting sites

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 as a result 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 a partial pressure of oxygen (pO2) at the beginning of the incubation, resulting from the microbial decomposition of organic matter, influence in the low hatching success (Bezy et. al., 2015).

The reproductive success of sea turtles depends largely on the stability of the nesting beaches, and that a 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, in the framework of the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC), has recognized that the effects of climate change impact the nesting and feeding habits of sea turtles, so in some of its index beaches the project called "Pilot Project for IAC Countries Parties for the collection of environmental parameters of their nesting index beaches" will be implemented for a continuous period of 5 years, based on the Resolution on the impacts of the Climate in the Sea Turtle habitats CIT-COP4-2009-R5- (http://www.iacseaturtle.org/docs/resolucionesCOP4CIT/CIT-COP4-2009-R5ESP_Final.pdf).

3.3.2. Marine 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 due to the fact that 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 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 information to consider in the measures to mitigate threats is that much of the effort of this fishery occurs both near and far from the 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 65 reported sites where nesting occurs, 27 of them are within a protected wildlife area. Twelve are the areas that have been created for marine conservation and that are under the administration of SINAC, and ten are the marine areas of responsible fishing under the administration of the National Fisheries Institute. The olive ridleys could eventually move within these spaces (Fig. 1a and 1b).

Other conservation details and priorities that are shared for all species of marine turtles can be seen in section 1.4. Table 4 shows a list of monitoring and research programs led by NGOs and government institutions.

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. Marine debris impacts on sea turtles (including ingestion of plastics, ghost gear,
microplastics)

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

4. RMU: *Eretmochelys imbricata*, Eastern Pacific Ocean (EI-EPO)

4.1. Distribution, abundance, trends

4.1.1. 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 and in a sporadically way in 15 sites of the Pacific coast (Fig. 12), 8 of them are in protected wildlife areas and 7 outside protected areas. For the purposes of this report, the information was collected from 3 sites, two of which are specifically foraging areas, and one a nesting beach. Historical data cites that between January 1982 to May 2009, only 48 individuals were observed nesting in Costa Rica (Gaos et. al., 2010). For the period comprised between 2016-2018 in Playa Rajada, North Pacific, only 3 nests per year were reported (see Table 2). According to Chacón-Chaverri et. al. (2014b), in the South Pacific there are less than 25 nests per year. The foregoing highlights the vulnerability of the species in the Costa Rican Pacific.

4.1.2. 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 has been developed. These marine areas are: Golfo Dulce (Chacón-Chaverri et. al., 2014b); Cabo Blanco (Heidemeyer et. al., 2014); Punta Coyote (Carrión-Cortés et. al., 2013); Punta Pargos (Chacón-Chaverri et. al., 2014b; Heidemeyer et. al., 2014) and Bahía Matapalito (Heidemeyer et. al., 2014) (Fig. 9).

Unlike the low numbers in the amount of nesting females registered on nesting beaches, Chacón-Chaverri et. al. (2014b) reported a catch of 62 individuals in the Golfo Dulce for the period 2010-2013. An important fact is that the greatest number of captures occurred when the greatest sampling effort was presented. In this aggregation site, the individuals captured were mostly adults and are likely to be feeding 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 (Carrión-Cortés et al., 2013). 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. 9c). 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.

4.2. Other biological data

Table 1 shows a summary of important biological data for the specie in the Costa Rican Pacific.

4.3. Threats

1.3.1. 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 in 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.

1.3.2. 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.

4.4. Conservation

From the 15 sites in which hawksbill turtle has been reported, 8 of them are protected under some category of government management, National Wildlife Refuge or National Park. In 7 sites there is a monitoring and research program for sea turtles at least during the peak of the season. Twelve are the areas that have been created for marine conservation and that are under the administration of SINAC and ten are the marine areas of responsible fishing, under the administration of the National Fisheries Institute. Through these spaces the hawksbill turtles could eventually move (Fig.1a, 1b).

Other conservation details and priorities that are shared for all species of marine turtles can be seen in section 1.4. Table 4 shows a list of monitoring and research programs led by NGOs and government institutions.

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 on techniques to reduce the incidental capture of sea turtles.

3. Marine debris impacts on sea turtles (including ingestion of plastics, ghost gear,
microplastics)

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

Acknowledgements

We express our deepest gratitude to all the people, NGOs, officials of SINAC, Incopesca, Coastguards and donors who with their effort and commitment make it possible for the country to consolidate a process of conservation, research and monitoring of sea turtles. Special thanks to our research assistants, volunteers, collaborators of the communities, as well as to Roxana Pizarro, Fabian Bonilla, Adrían Mora and Martin Mendez.

Table 1. Main biology and conservation aspects of sea turtles in the Costa Rican Pacific.

RMU:	(CM) Eastern Pacific	Ref #	(LO) arribadas-Eastern Pacific	Ref #	(LO) solitarias-Eastern Pacific	Ref #	(DC) Eastern Pacific	Ref #	(Ei) Eastern Pacific
Occurrence									
Nesting sites	Y	2,26,29,30,34	Y	PS,2,40	Y	PS, 2,58	Y	PS,2,3,4,57	N
Pelagic foraging grounds	N	PS	N	PS	N	PS	N	PS	N
Benthic foraging grounds	JA	33,34,54,55	N	PS	N	PS	N	PS	JA
Key biological data									
Nests/yr: recent average (range of years)	1978(2014-2018)	PS,2, 30	955434 (2014-2018)	PS,2	2603 (2014-2018)	PS, 2	206 (2014-2018)	PS,2	3 (2016-2018)
Nests/yr: recent order of magnitude	5-1698	PS	49383- 1390985	PS	53-4283	PS	1-171	PS	unknown
Number of "major" sites (>20 nests/yr AND >10 nests/km yr)	11	PS	2	PS	15	PS	1	PS	0
Number of "minor" sites (<20 nests/yr OR <10 nests/km yr)	5	PS	0	PS	2	PS	5	PS	1
Nests/yr at "major" sites: recent average (range of years)									
Nests/yr at "minor" sites: recent average (range of years)									
Total length of nesting sites (km)	25.2	PS	8.4	PS	46.9	PS	25.4	PS	unknown
Nesting females / yr	597	PS	584418	PS	2506	PS	34.8	PS	unknown
Nests / female season (N)	3.16	PS	2.2	PS	1,65 (1929)	PS	4,11 (>110)	PS	unknown
Female remigration interval (yrs) (N)	2,6(63)	PS	unknown		unknown		3.65	17	unknown
Sex ratio: Hatchlings (F / Tot) (N)	unknown		unknown		unknown		0.85	27	unknown
Sex ratio: Immatures (F / Tot) (N)	unknown		unknown		unknown		unknown		unknown
Sex ratio: Adults (F / Tot) (N)	unknown		unknown		unknown		unknown		0.66 (57)
Min adult size, CCL or SCL (cm)	79.20	PS	60,75 (3083)	PS	66,5 (3037)	PS	144	PS	58.00
Age at maturity (yrs)	20-30	PS							
Clutch size (n eggs) (N)	73,6(3955)	PS	92,7 (8484)	PS	88,9 (3688)	PS	66,3 (706)	PS	unknown
Emergence success (hatchlings/egg) (N)	0,85 (2532)	PS	0,26 (8484)	PS	0,79 (6295)	PS	0.28 (>1000)	PS	unknown
Nesting success (Nests/ Tot emergence tracks) (N)	0,60 (5154)	PS	unknown		unknown		0.90	PS	unknown

Trends									
Recent trends (last 20 yrs) at nesting sites (range of years)	unknown		Stable	PS, 40	unknown	PS	Declining (90%)(1988-2018)	3,57,64	Declining
Recent trends (last 20 yrs) at foraging grounds (range of years)	unknown		n/a		unknown	PS	n/a		n/a
Oldest documented abundance: nests/yr (range of years)	n/a		Y	38, 42	unknown	PS	Y	8,9,,6	n/a
Published studies									
Growth rates	N	PS	N	PS	N	PS	Y	62	N
Genetics	Y	29.54	N	PS	N	PS	Y	60	Y
Stocks defined by genetic markers	Y	29,34,54	N	PS	N	PS	Y		Y
Remote tracking (satellite or other)	Y	26	N	PS	N	PS	Y	10,11,12	N
Survival rates	N		N	PS	N	PS	Y		N
Population dynamics	N		N	PS	N	PS	Y	3,4,27,57	N
Foraging ecology (diet or isotopes)	Y	PS	N	PS	N	PS	Y	59	Y
Capture-Mark-Recapture	Y	PS,31	Y	PS	Y	PS	Y	PS,4,5,6,7,8	Y
Threats									
Bycatch: presence of small scale / artisanal fisheries?	Y (SN, OTH)	PS	Y(PLL, ST,)	PS	Y(PLL, ST,)	PS	N		Y (SN, OTH)
Bycatch: presence of industrial fisheries?	Y (PLL, SN, BT)		Y(PLL, ST,)	PS	Y(PLL, ST,)	PS	N		Y (PLL, SN, BT)
Bycatch: quantified?	N		10 (PLL)/9,4 per 1000 hooks (Mahi mahi fisheries)	PS,48, 49	10 (PLL)/9,4 per 1000 hooks (Mahi mahi fisheries)	PS, 48,49	N		N
Take. Intentional killing or exploitation of turtles	N		N	PS	N	PS	N		Y (2-5 per year)
Take. Egg poaching	Y	2	Y	PS	Y	PS	Y	57	Y
Coastal Development. Nesting habitat degradation	Y	2	Y	PS	Y	PS	Y	14	Y
Coastal Development. Photopollution	Y	2	Y	PS	Y	PS	Y		Y
Coastal Development. Boat strikes	Y (2-5 per year)	2	Y (7-10 Per year)	PS	Y (7-10 Per year)	PS	Y		Y (2-5 per year)
Egg predation	Y	PS	Y	PS	Y	PS	Y		Y
Pollution (debris, chemical)	Y	2	Y	PS	Y	38	Y	65	Y
Pathogens	Y	2	Y	PS	Y	PS	n/a		Y

Climate change	Y	2	Y	PS	Y	PS	Y	15,16,20,21,66,67,68	Y
Foraging habitat degradation	Y (Contaminants)	2	Y	PS	Y	PS	N		Y (Contaminants)
Other	Y (Ghost fishing gear)	PS	Artisanal fisheries	PS	Artisanal fisheries	PS	N		Y (Ghost fishing gear)
Long-term projects									
Monitoring at nesting sites	Y		Y	PS	Y	PS	Y		Y
Number of index nesting sites	5	2	2	PS	1	PS	1		0
Monitoring at foraging sites	Y	31,34,54,55,56	n/a		n/a		n/a		Y
Conservation									
Protection under national law	Y	2	Y	2	Y	2	Y	2	Y
Number of protected nesting sites (habitat preservation)	4	PS	2	PS	3	PS	9	PS	8
Number of Marine Areas with mitigation of threats	22	PS	22	PS	22	PS	22	PS	22
Long-term conservation projects (number)	19	PS	2	PS	17	PS	6	PS	3
In-situ nest protection (eg cages)	Y	PS	Y	PS	Y	PS	Y	PS	Y
Hatcheries	Y	PS	Y	PS	Y	PS	Y	PS	N
Head-starting	N	PS	N	PS	N	PS	N	PS	N
By-catch: fishing gear modifications (eg, TED, circle hooks)	Y (TED)	PS	N	PS	N	PS	N	PS	Y (TED)
By-catch: onboard best practices	Y	PS	N	PS	N	PS	N	PS	Y
By-catch: spatio-temporal closures/reduction	N	PS	N	PS	N	PS	N	PS	N
Other	N	PS	N	PS	N	PS	N	PS	N

Table 2. Sea turtle nesting beaches in the Costa Rican Pacific.

RMU / Nesting beach name	Index site	Nests/yr: recent average (range of years)	Central point		Length (km)	% Monitored	Reference #	Monitoring Level (1-2)	Monitoring Protocol (A-F)
CM-NW IND			Long	Lat					
Nombre de Jesús-Zapotillal	Y	655 (2014-2018)	-85.834599	10.39442	1.7	100	PS	1	D
Cabuyal	Y	237 (2014-2018)	-85.653405	10.675365	1.4	100	PS	1	D
Isla San José	Y	597 (2014-2017)	-85.912374	10.856928	0.125	100	PS	1	D
Nancite	N	15 (2014-2018)	-85.711894	10.809324	1.05	100	PS	1	D
Naranjo	N	35 (2014-2018)	-85.699344	10.805686	4	50	PS	2	D
Coyotera	N	5 (2016-2018)	-85.721481	11.041878	0.900	100	PS	1	D
Coquito	N	9,5 (2017-2018)	-85.732365	11.045944	0.350	100	PS	1	D
El Jobo	N	68 (2016-2018)	-85.734743	11.033851	0.750	100	PS	1	D
Rajadita	N	25 (2016-2018)	-85.75139	11.025429	0.300	100	PS	1	D
Rajada	N	30 (2016-2018)	-85.746064	11.028376	0.800	100	PS	1	D
Piro	N	49 (2014-2018)	-83.338702	8.3954722	2	100	PS	1	D
Pejeperro	N	168(2014-2018)	-83.371519	8.4073861	4.5	100	PS	1	D
Junquillal	N	15(2015-2018)	-85.809437	10.161793	5.3	100	PS	1	D

Pargos (Avellanas, Lagartillo, Negra, Callejones, Blanca)	N	108 (2012-2018)	-85.836332	10.201512	7.7	100	PS	1	D
DC-NW IND									
Parque Nacional Marino Baulas (Grande, Ventanas y Langosta)	Y	125 (2013/14-2017/18)	-85.843432	10.327754	6	100	PS	1	D
Ostional	N	23 (2004-2015)	-85.700403	9.993913	7	100	9	1	D
Nombre de Jesús y Zapotillal	N	10 (2010-2018)	-85.834599	10.39442	1.7	100	PS	1	D
Cabuyal	N	16 (2013/14-2017/18)	-85.653405	10.675365	1.4	100	PS	1	D
Naranjo	N	18 (2014-2018)	-85.699344	10.805686	4	95	PS	2	D
Junquillal	N	17(2014-2018)	-85.809437	10.161793	5.3	100	PS	1	D
LO-NW IND									
Nancite	Y	81455 (2014-2018)	-85.711894	10.809324	1.05	100	PS	1	F
Naranjo	N	764 (2014-2018)	-85.699344	10.805686	4	50	PS	2	
Ostional	Y	873979 (2014-2018)	-85.700403	9.993913	7	100	PS	1	F
Camaronal	Y	2076(2014-2018)	-85.444924	9.86236	3	100	PS	1	D
Rajada	N	67 (2016-2018)	-85.746064	11.028376	0.900	100	PS	1	D
Rajadita	N	16 (2016-2018)	-85.75139	11.025429	0.300	100	PS	1	D

El Jobo	N	18 (2016-2018)	-85.734743	11.033851	0.750	100	PS	1	D
Coquito	N	45,5 (2017-2018)	-85.732365	11.045944	0.350	100	PS	1	D
Coyotera	N	78,3 (2017-2018)	-85.721481	11.041878	0.900	100	PS	1	D
San Miguel	Y	6000 (1998-2018)	-85.311402	9.81221	2.5	100	PS	1	D
Costa de Oro	Y	2400 (2012-2018)	-85.284919	9.796089	4.6	100	PS	1	D
Bejuco	Y	2000 (2016-2018)	-85.332842	9.822719	3.5	100	PS	1	D
Corozalito	Y	18000 (2008-2018)	-85.37777	9.847904	0.800	100	PS	1	D
Piro	N	515(2014-2018)	-83.338702	8.3954722	2	100	PS	1	D
Pejeperro	N	707(2014-2018)	-83.371519	8.4073861	4.5	100	PS	1	D
Playa Montezuma	N	1403 (2011-2018)	-85.063628	9.6580138	0.8	100	PS	1	D
Playa Buena Vista	N	461 (2017-2018)	-85.941333	10.468641	1.8	100	PS	1	D
Junquillal	N	229(2015-2018)	-85.809437	10.161793	5.3	100	PS	1	D
Hermosa	N	1424 (2002-2011)	-84.5869478	9.5727856	8	50	22	2	D
Ei-NW IND									
Rajada	N	3 (2016-2018)	-85.746064	11.028376	0.8	100	PS	1	D

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

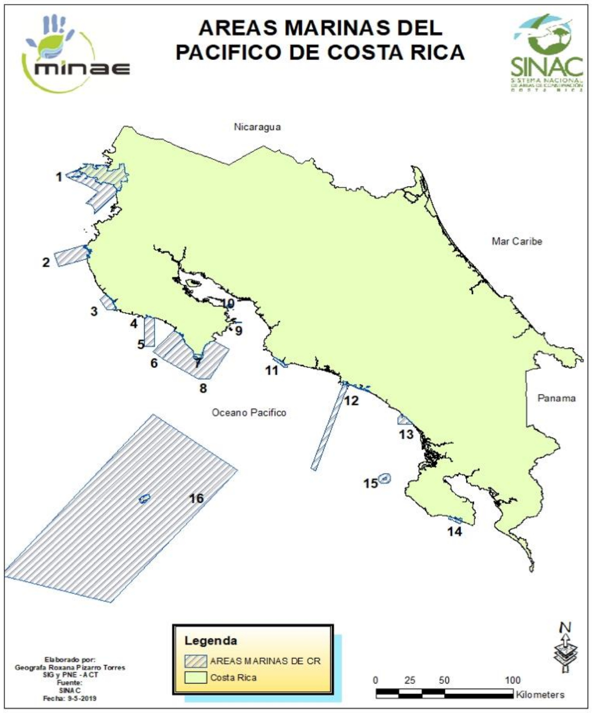
International Conventions	Signed	Binding	Compliance measured and reported	Species	Conservation actions	Relevance to sea turtles
Inter-American Convention (IAC) for the Protection and Conservation of Sea Turtles	Y	Y	Y	ALL		
Convention on International Trade in Endangered Species of Wild Fauna and Flora (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 through appropriate financing.	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
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. Organizations and agencies related with sea turtle research and conservation in the Costa Rican Pacific.

Organization	Contact person	e-mail
Reserva Playa Tortuga	Oscar Brenes	oscarbreari@gmail.com
Fundación Corcovado	Aida García Solá	aida@corcovadofoundation.org
Comité para la Conservación de las Tortugas Marinas de Corcovado (COTORCO)	Pilar Bernal	cotorco@adicorcovado.org
Latin American Sea Turtle (LAST)	Luis Fonseca	luisfonsecalopez@gmail.com
WIDECAST	Didiher Chacón	dchacon@widecast.org
Conservación OSA	Mónica Espinoza Miralles	monicaespinoza@osaconservation.org
Asociación Vecinos Punta Banco		puntabancoambiental@gmail.com
The Leatherback Trust	María del Pilar Santidrian-Tomillo	bibi@leatherback.org
Asociación Kuemar	Elizabeth Vélez	evelez@kuemar.org
SINAC/ACT	Rotney Piedra	rotney.piedra@sinac.go.cr
Sea Turtle Forever	Nancy Tankersley	akwildguide@yahoo.com
ASVO	Greivin Fallas	jipifallas@yahoo.com
Asociación Vida Verdiazul	Valerie Guthrie	valerie@verdiazulcr.org
CREMA / Turle Trax	Isabel Naranjo	inaranjo@cremacr.org
Cirenas	Keylin Torres	info@cirenas.org
Refugio Nacional Mixto de Vida Silvestre Romelia	Oscar Cubero Vasquez	samanea88@gmail.com
Equipo Tora Carey /Universidad de Costa Rica	Maike Heidemeyer	maike.heidemeyer@gmail.com
Refugio Nacional Mixto de Vida Silvestre Barú	Alberto Villarreal Bogarín	info@haciendabaru.org
Tambor Bay Turtles	Javier Carazo	carazo.javier@gmail.com



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

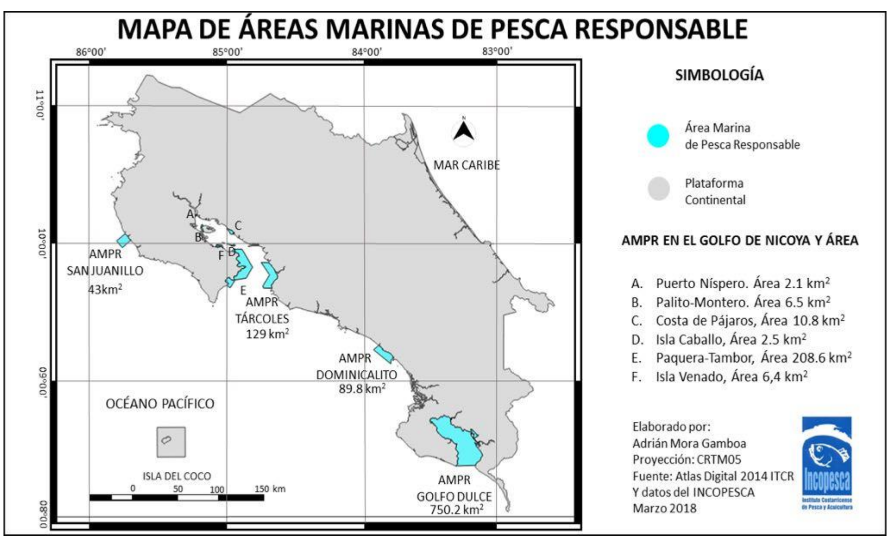
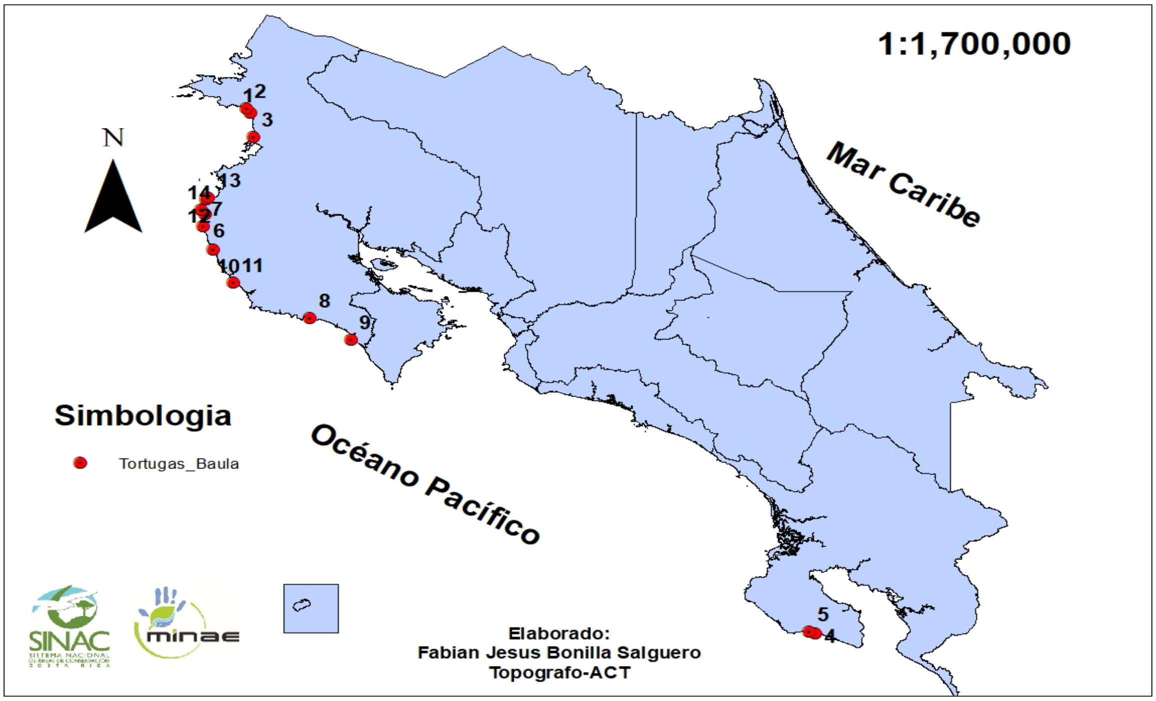


Figure 1. a). Map of Marine Protected Areas and Marine Management Areas, Pacific of Costa Rica (Source: SINAC); b). Marine Areas of Responsible Fishing, Pacific of Costa Rica (Source: INCOPESCA).

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



Simbologia

- <all other values>

Numero, Nombre de Playa, Area Conservacion

- 1, Nancite, ACG
- 10, Junquillal, ACT
- 11, Ostional, ACT
- 12, Nombre de Jesús, ACT
- 13, Playa Minas, ACT
- 14, Playa Ventanas, ACT
- 2, Playa Naranjo, ACG
- 3, Cabuyal, ACG
- 4, Carate, ACOSA
- 5, Playa La Leona, ACOSA
- 6, Playa Grande, ACT
- 7, Langosta, ACT
- 8, Camaronal, ACT
- 9, Playas Ario Caletas, ACT

Figura 3. Nesting beaches where leatherbacks are reported.

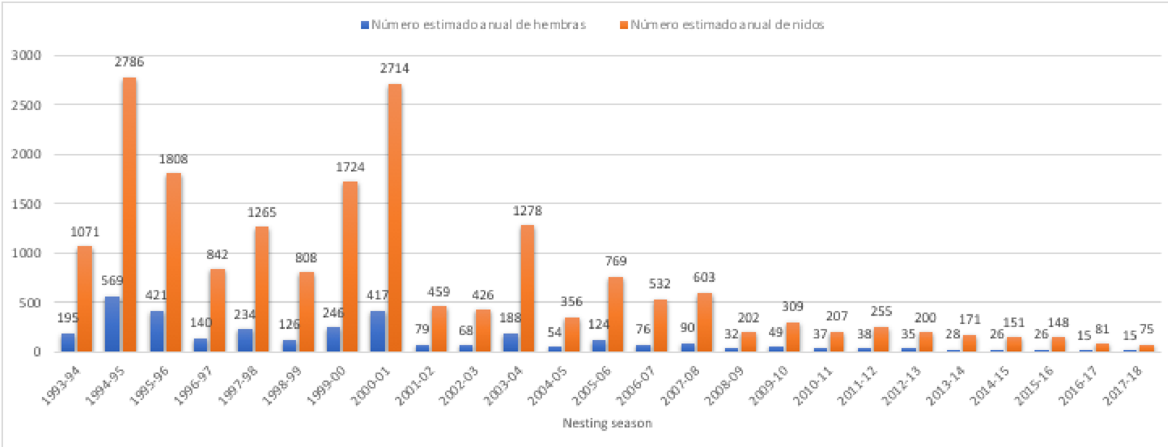


Figure 4. Estimated anual number of females and estimated anual number of nest. Source from TLT, KUEMAR, SINAC.

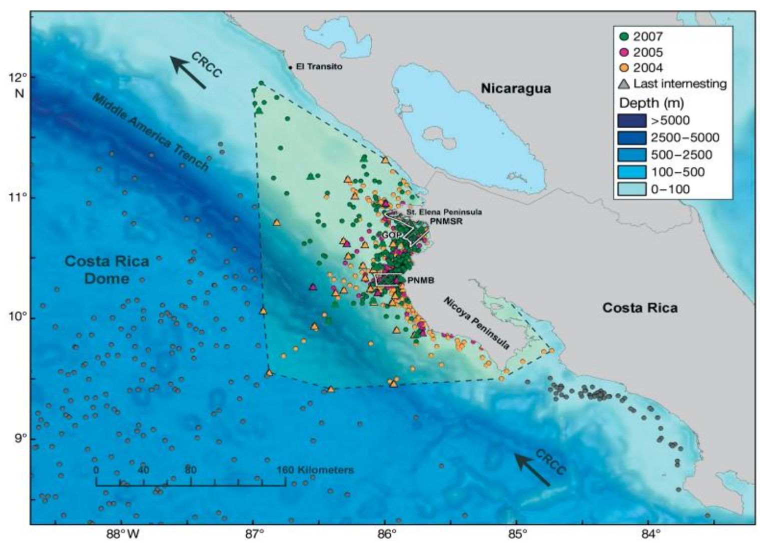


Figure 5. The polygon shows the area where the leatherbacks move during their internesting period. (**Map taken from Shillinger et. al., 2010**).

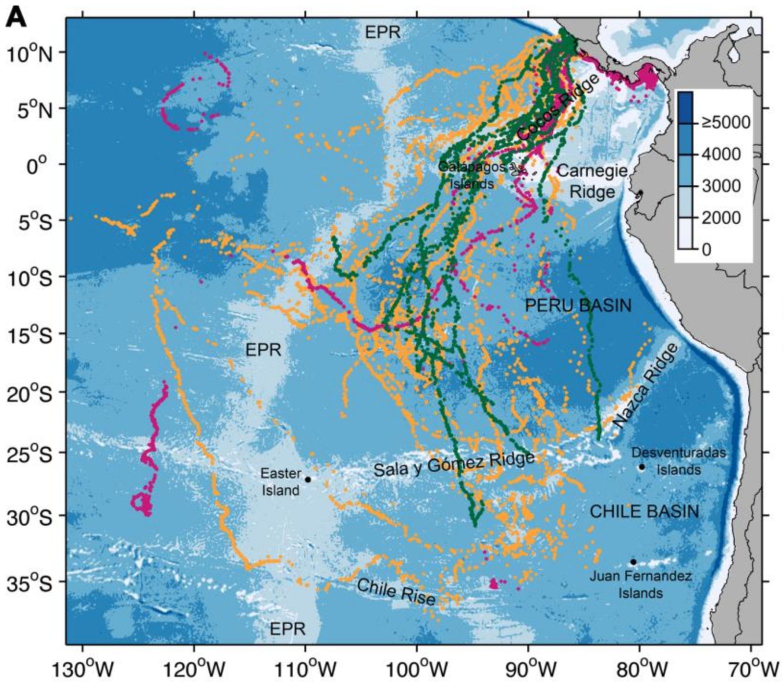
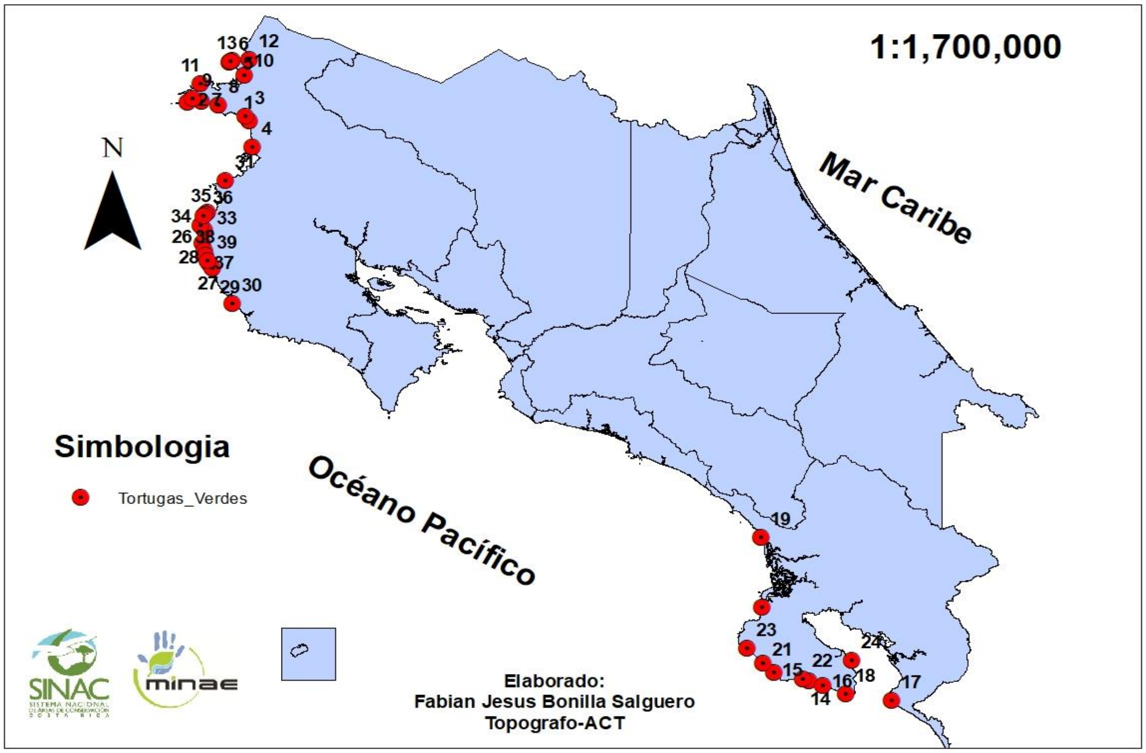


Figure 6. Migration route. Satellite transmission positions for *Dermochelys coriacea* from 2004, 2005 and 2007 (**Map taken from Shillinger et. al., 2008**).



Simbologia

- <all other values>

Numero, Nombre de Playa, Area de Conservacion

- 1, Nancite, ACG
- 10, Playa Junquillal, ACG
- 11, Playa Blanca, ACG
- 12, Coyotera, ACG
- 13, Rajadita, ACG
- 14, Carate, ACOSA
- 15, Sirena, ACOSA
- 16, Pejeperro, ACOSA
- 17, Punta Banco, ACOSA
- 18, Playa Piro, ACOSA
- 19, Playa Garza, ACOSA
- 2, Isla San José, ACG
- 20, Playa Ganado, ACOSA
- 21, Playa Corcovado, ACOSA
- 22, Playa La Leona, ACOSA
- 23, Playa Llorona, ACOSA
- 24, Playa Preciosa-Platanares, ACOSA
- 25, Playa Grande, ACT
- 26, Langosta, ACT
- 27, Playa Blanca, ACT
- 28, Playa Callejones, ACT
- 29, Junquillal, ACT
- 3, Playa Naranjo, ACG
- 30, Ostional, ACT
- 31, Matapalo, ACT
- 32, Nombre de Jesús, ACT
- 33, Playa Minas, ACT
- 34, Playa Ventanas, ACT
- 35, Playa Real, ACT
- 36, Playa Onda, ACT
- 37, Playa Avellanas, ACT
- 38, Playa Lagartillo, ACT
- 39, Playa Negra, ACT
- 4, Cabuyal, ACG
- 5, El Jobo, ACG
- 6, Playa Rajada, ACG
- 7, Playa Colorada, ACG
- 8, Playa Potrero Grande, ACG
- 9, Isla Pelada, ACG

Figure 7. Nesting beaches where green turtles are reported.

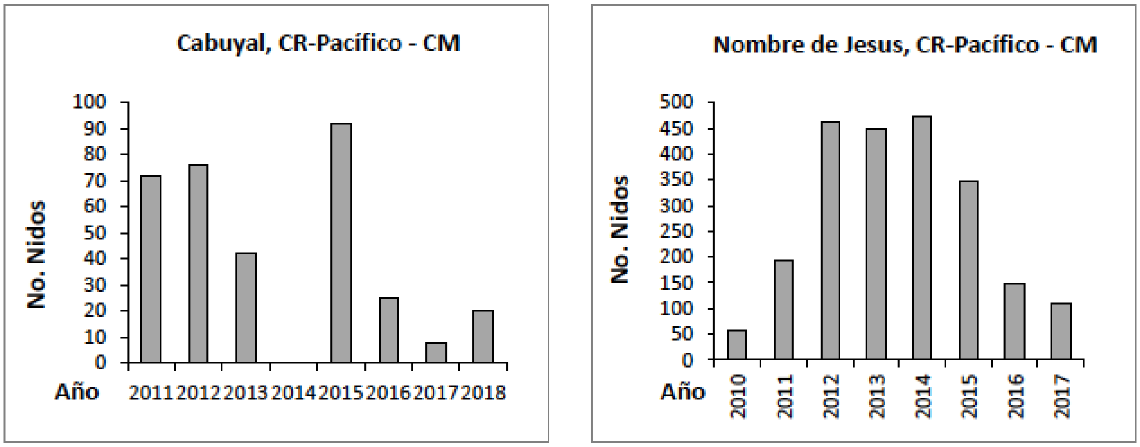


Figure 8. Number estimated of green turtle nest in index beaches (Cabuyal, Nombre de Jesús) (CIT 2018).

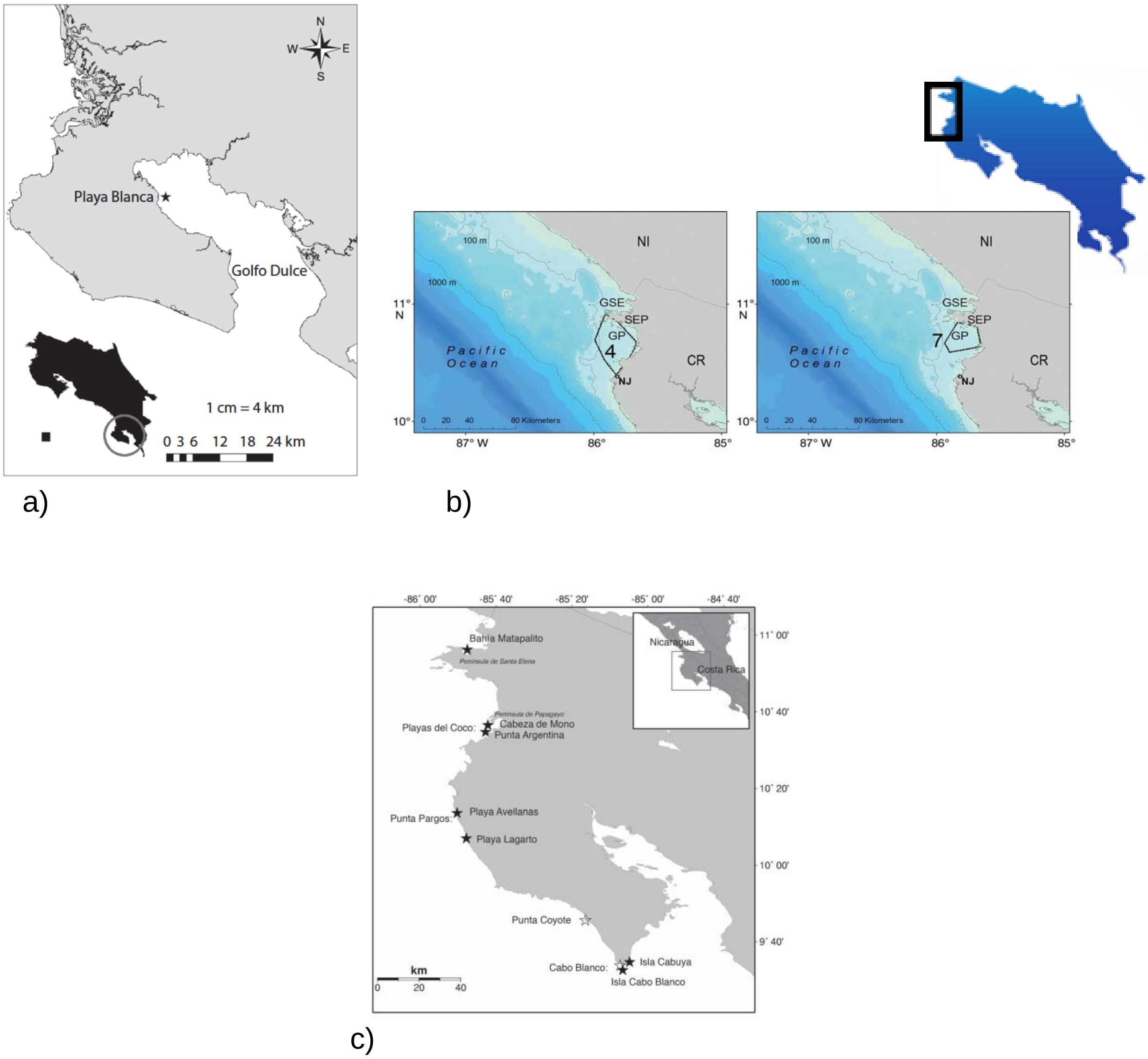
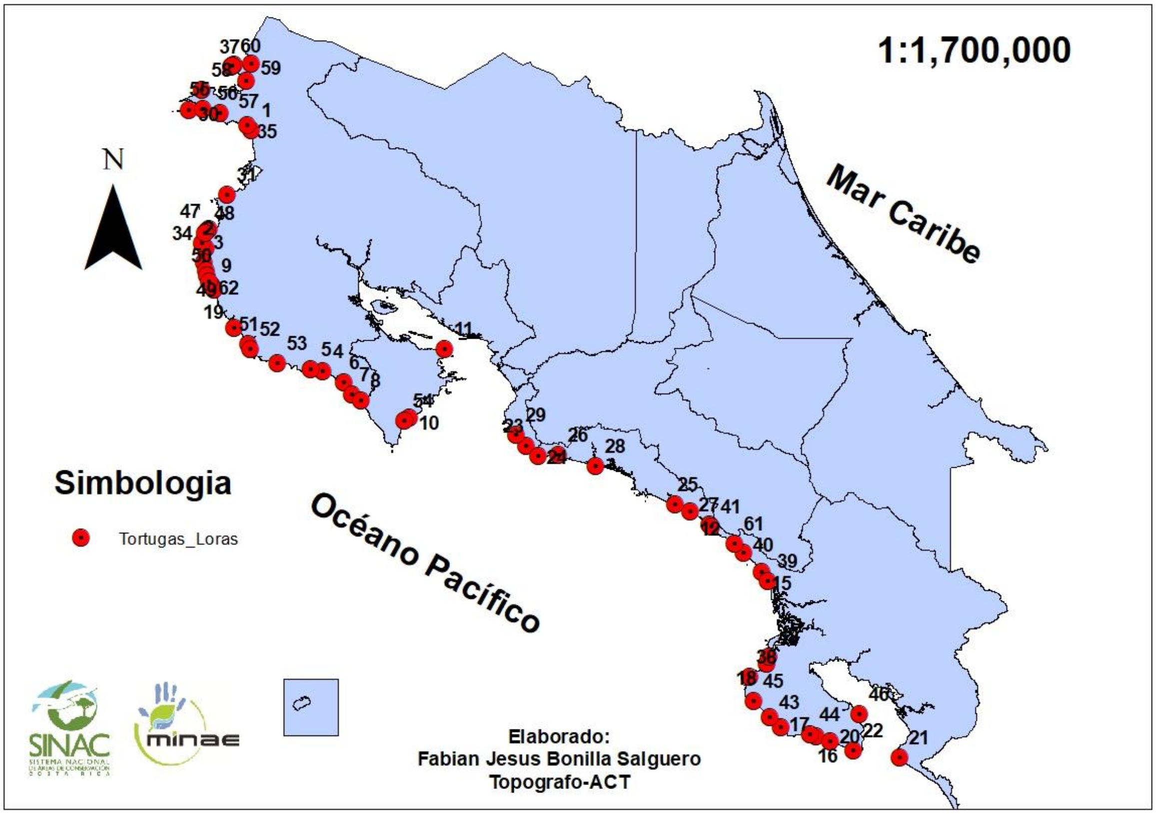


Figure 9. Foraging areas for balck turtle (a, b, c) and Hawksbill turtle (a, c) in the Pacific of Costa Rica. a). Golfo dulce (**Map taken from Chaverri-Chacón et. al., 2014a**); b). Gulf of Papagayo (GP) and Gulf of Santa Elena (GSE) two foraging areas of green turtles from Nombre de Jesús (NJ), Costa 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**).



Simbologia

- <all other values>

Numero, Nombre de Playa, Area Conservacion

- 1, Nancite, ACG
- 10, RNVS Romelia, ACT
- 11, Playa Cocos RNVSSL, ACOPAC
- 12, Matapalo, ACOPAC
- 13, Playa Callejones, ACT
- 14, Junquillal, ACT
- 15, Playa Tortuga, ACOSA
- 16, Carate, ACOSA
- 17, Sirena, ACOSA
- 18, Drake, ACOSA
- 19, Ostional, ACT
- 2, Playa Grande, ACT
- 20, Pejeperro, ACOSA
- 21, Punta Banco, ACOSA
- 22, Playa Piro, ACOSA
- 23, Playa Hermosa, ACOPAC
- 24, Punta Mala, ACOPAC
- 25, Playa Rey, ACOPAC
- 26, Esterillos, ACOPAC
- 27, Barú, ACOPAC
- 28, Palo Seco, ACOPAC
- 29, Jacó, ACOPAC
- 3, Langosta, ACT
- 30, Isla San José, ACG
- 31, Matapalo, ACT
- 32, Nombre de Jesús, ACT
- 33, Playa Minas, ACT
- 34, Playa Ventanas, ACT
- 35, Playa Naranjo, ACG
- 36, El Jobo, ACG
- 37, Playa Rajada, ACG
- 38, Playa San Josecito, ACOSA
- 39, Playa Garza, ACOSA
- 4, Corozalito, ACT
- 40, Playa Colonia, ACOSA
- 41, Playa Dominical, ACOSA
- 42, Playa Ganado, ACOSA
- 43, Playa Corcovado, ACOSA
- 44, Playa La Leona, ACOSA
- 45, Playa Llorona, ACOSA
- 46, Playa Preciosa-Platanares, ACOSA
- 47, Playa Real, ACT
- 48, Playa Onda, ACT
- 49, Playa Avellanas, ACT
- 5, Camaronal, ACT
- 50, Playa Lagartillo, ACT
- 51, Playa Pelada, ACT
- 52, Playa Guiones, ACT
- 53, Playa Buena Vista, ACT
- 54, Playa Montezuma, ACT
- 55, Playa Colorada, ACG
- 56, Playa Potrero Grande, ACG
- 57, Playa Junquillal, ACG
- 58, Playa Blanca, ACG
- 59, Coyotera, ACG
- 6, Playa San Miguel, ACT
- 60, Rajadita, ACG
- 61, Playa Hermosa, ACOSA
- 62, Playa Negra, ACT
- 7, Playas Ario Caletas, ACT
- 8, Pencal, ACT
- 9, Playa Blanca, ACT

Figure 10. Nesting beaches where Olive ridley turtles are reported.

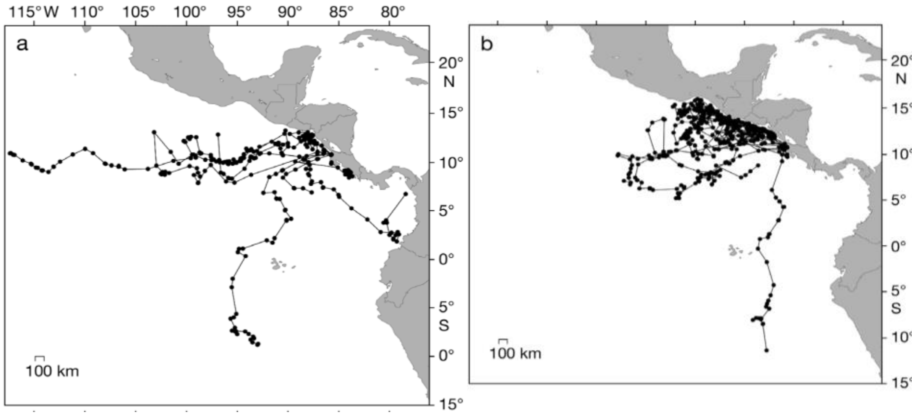
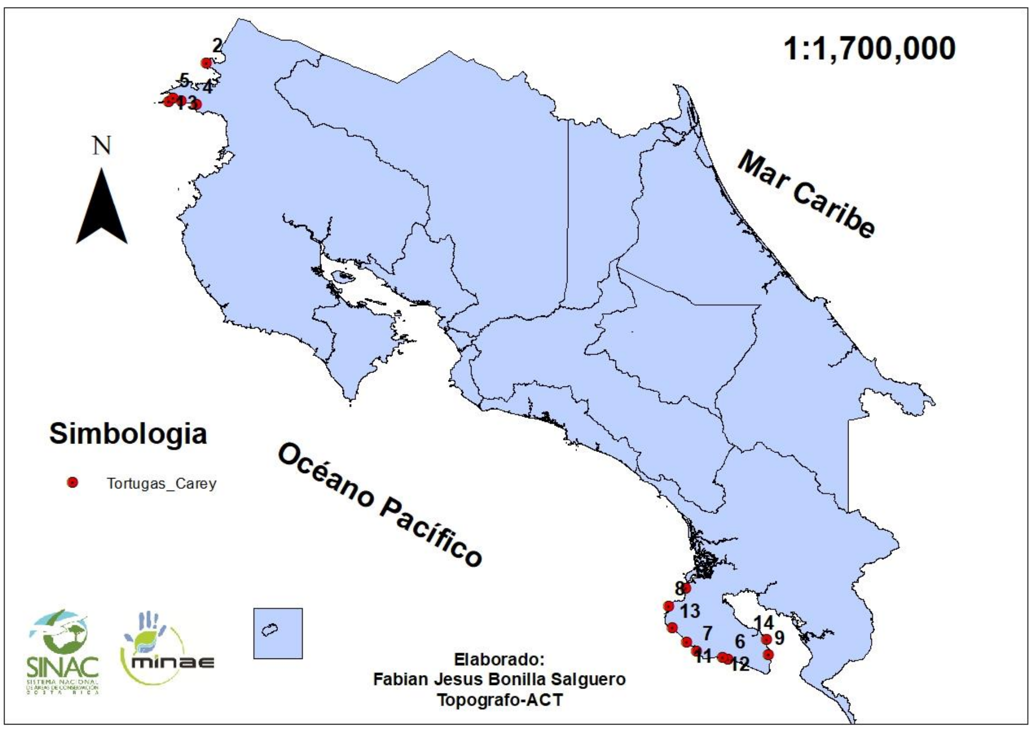


Figure 11. *Lepidochelys olivacea.* Post-nesting migrations of 20 female olive ridleys during (a) 1990–1991 and (b) 1991–1992. **Map taken from Plotkin 2010**.



Simbologia

- <all other values>

Numero, Nombre de Playa, Area Conservacion

- 1, Isla San José, ACG
- 10, Playa Ganado, ACOSA
- 11, Playa Corcovado, ACOSA
- 12, Playa La Leona, ACOSA
- 13, Playa Llorona, ACOSA
- 14, Playa Preciosa-Platanares, ACOSA
- 2, Playa Rajada, ACG
- 3, Playa Colorada, ACG
- 4, Playa Potrero Grande, ACG
- 5, Isla Pelada, ACG
- 6, Carate, ACOSA
- 7, Sirena, ACOSA
- 8, Playa San Josecito, ACOSA
- 9, Playa Tamales, ACOSA

Figure 12. Nesting beaches where hawksbill turtles are reported.

REFERENCES

1. MINAE 2018. Estrategia Nacional para la Conservación y Protección de las Tortugas Marinas en Costa Rica.

2. MINAE-SINAC 2018. Informe Anual 2018 Costa Rica. Convención Inter-Americana para la Protección y Conservación de las Tortugas Marinas.

3. Santidrián Tomillo, P., Vélez, E., Reina, R.D., Piedra, R., Paladino, F.V. and Spotila, J.R. 2007. Reassesment of the leatherback turtles (Dermochelys coriacea) nesting population at Parque Nacional Marino Las Baulas, Costa Rica: effects ofconservation efforts. Chelonian Conservation Biology 6: 54-62.

4. Santidrián-Tomillo, P., Robinson, N. J., Fonseca, L. G., Quirós-Pereira, W., Arauz, R., Beange, M.,Piedra, R; Vélez, E; Paladino, F; Spotila, J & Wallace, B. P. 2017a. Secondary nesting beaches for leatherback turtles on the Pacific coast of Costa Rica. Latin american journal of aquatic research, 45(3), 563-571.

5. Piedra, R., Velez, E., Dutton, P.H., Possardt, E., and Padilla, C. 2007. "Nesting of the leatherback turtle (Dermochelys coriacea) from 1999–2000 through 2003–04 at Playa Langosta, Parque Nacional Marino Las Baulas de Guanacaste, Costa Rica. Chelonian Conservation and Biology 6(1):111–116.

6. Steyermark, A.C., Williams, K., Spotila, J.R., Paladino, F.V., Rostal, D.C., Morreale, S.J., Kobert, M.T., and Arauz, R. 1996. Nesting leatherback turtles at Las Baulas National Park, Costa Rica. Chelonian Conservation and Biology 2(2):173–183.

7. Chaves, A., Serrano, G., Marin, G., Arguedas, E., Jimenez, A., and Spotila, J.R. 1996. Biology and conservation of leatherback turtles, Dermochelys coriacea, at Playa Langosta, Costa Rica. Chelonian Conservation and Biology 2(2): 184–189.

8. Reina, R.D., Mayor, P.A., Spotila, J.R., Piedra, R., and Paladino, F.V. 2002. Nesting ecology of the leatherback turtle, Dermochelys coriacea, at Parque Nacional Marino Las Baulas, Costa Rica: 1988–1989 to 1999–2000. Copeia 2002: 653–664.

9. Spotila, J.R., R.D. Reina, A.C. Steyermark, P.T. Plotkin & F.V. Paladino. 2000. Pacific leatherback turtles face extinction. Nature, 405: 529-530.

10. Shillinger, G. L., A. M. Swithenbank, S. J. Bograd, H. Bailey, M. R. Castelton, B. P. Wallace, J. R. Spotila, F. V. Paladino, R. Piedra, and B. A. Block. 2010. Identification of high-use internesting habitats for eastern Pacific leatherback turtles: role of the environment and implications for conservation. Endangered Species Research 10:215–232.

11. Shillinger, G. L., D. M. Palacios, H. Bailey, S. J. Bograd, A. M. Swithenbank, P. Gaspar, B. P. Wallace, J. R. Spotila, F. V. Paladino, R. Piedra, S. A. Eckert, and B. A. Block. 2008. Persistent leatherback turtle migrations present opportunities for conservation. PLoS Biology 6:e171.

12. Shillinger, G. L., A. M. Swithenbank, H. Bailey, S. J. Bograd, M. R. Castelton, B. P. Wallace, J. R. Spotila, F. V. Paladino, R. Piedra, and B.A. Block. 2011. Vertical and horizontal habitat preferences of post-nesting leatherback turtles in the South Pacific Ocean. Marine Ecology Progress Series 422:275–289.

13. Bailey, H., Benson. S.R., Shillinger, G., Bograd, S.J., Dutton, P.H., Eckert, S.A., Morreale, S.J., Paladino, F.V., Eguchi, T., Foley, D.G., Block, B., Piedra, R., Hitipeuw, C., Tapilatu, R., and Spotila, J. 2012. Identification of distinct movement patterns in Pacific leatherback turtle populations influenced by ocean conditions. Ecol. Appl. 22, 735–747. (doi:10.1890/11-0633).

14. Roe, J.H., P.R. Clune & F.V. Paladino. 2013. Characteristics of la leatherback nesting beach and implications for coastal development. Chelonian Conserv. Biol., 12: 34-43.

15. Santidrián, Tomillo P., Saba, V.S., Blanco, G.S., Stock, C.A., Paladino, F.V., Spotila, J.R., 2012. Climate driven egg and hatchling mortality threaten survival of eastern Pacific leatherback turtles. PLoS ONE 7 (5), e37602.

16. Saba, V.S., Stock, C.A., Paladino, F.V., Spotila, J.R., Santidrián Tomillo, P. 2012. Projected population response of an endangered marine turtle population to climate change. Nat. Clim. Change 2: 814–820.

17. Santidrián Tomillo, P., Robinson, N.J., Sanz-Aguilar, A., Spotila, J.R., Paladino, F.V. and Tavecchia, G. 2017b. High and variable mortality of leatherback turtles reveal possible anthropogenic impacts. Ecology 98:2170-2179.

18. Alfaro-Shigueto, J., Mangel, J., Darquea, J., Donoso, M., Barquero, A., Doherty, P.D., and B. Godley. 2018. Untangling the impacts of nets in the southeastern Pacific: Rapid assessment of marine turtle bycatch to set conservation priorities in small-scale fisheries. Fisheries Research 206: 185–192.

19. Roe, J.H., Morreale, S.J., Paladino, F.V., Shillinger, G.L., Benson, S.R., Eckert, S.A., Bailey, H., Santidrian Tomillo, P., Bograd, S.J., Eguchi, T., Dutton, P.H., Seminoff, J.A., Block R.A. and J. Spotila. 2014. Predicting bycatch hotspots for endangered leatherback turtles on longlines in the Pacific Ocean. Proc. R. Soc. B 281: 20132559. http://dx.doi.org/10.1098/rspb.2013.2559.

20. Saba, V.S., P. Santidri!an Tomillo, R. D. Reina, J. R. Spotila, J. A. Musick, D. A. Evans, and F. V. Paladino. 2007. The effect of the El Niño southern oscillation on the reproductive frequency of eastern Pacific leatherback turtles. Journal of Applied Ecology 44:395–404.

21. Reina, R.D., Spotila, J.R., Paladino, F.V, Dunham, A.E. 2009. Changed reproductive schedule of eastern Pacific leatherback turtles Dermochelys coriacea following the 1997–98 El Niño to La Niña transition. Endangered Species Research 7:155–161

22. Richard, J.D. and Hughes, D.A. 1972. Some observations of sea turtle nesting activity in Costa Rica. Marine Biology 16:297– 309.

23. Cornelius, S.E. 1976. Marine turtle nesting activity at Playa Naranjo, Costa Rica. Brenesia 8:1–27.

24. Drake, D.L., Behn, J.E., Hagerty, M.A., Mayor, P.A., Goldenberg, S.J., and Spotila, J.R. 2003. Marine turtle nesting activity at Playa Naranjo, Santa Rosa National Park, Costa Rica, for the 1998–1999 season. Chelonian Conservation and Biology 43:675–678.

25. Blanco, G.S., Morreale. S.J., Vélez, E., Piedra, R., Montes, W.M., Paladino, F.V., and J.R. Spotila. 2011. Reproductive output and ultrasonography of an endangered population of East Pacific green turtles. J Wildl Manag 76: 841−846.

26. Blanco, G, Morreale, S.; Seminof, J.; . Paladino, F; Piedra, R. and James R. Spotila. 2012a. Movements and diving behavior of internesting green turtles along Pacific Costa Rica. doi: 10.1111/j.1749-4877.2012.00298.x

27. Santidrián Tomillo, P., Oro, D. Paladino, F.V., Piedra, R., Sieg, A.E. and Spotila, J.R. 2014. High beach temperatures increased female-biased primary sex ratios but reduced output of female hatchlings in the leatherback turtle. Biological Conservation 176: 71-79.

28. Ureña López, R. 2014. Nesting of Pacific Green Turtle Chelonia mydas (Linnaeus 1758) at Playa Matapalo, Guanacaste, Costa Rica. Marine Turtle Newsletter 142:17– 18.

29. Dutton, P.H., Jensen, M.P., Frey, A., LaCasella, E., Balazs, G. H., Zarate, P., Chassin-Noria, O., Sarti-Martinez, A.L. and Vélez, E. 2014. Population structure and phylogeography reveal pathways of colonization by a migratory marine reptile (Chelonia mydas) in the central and eastern Pacific. Ecology and Evolution. 2014;4:4317–4331.

30. Fonseca, L.G., Santidrián Tomillo, P., Villachica, W.N., Quirós, W.M., Pesquero, M., Heidemeyer, M., Joyce, F., Plotkin, P.T., Seminoff, J.A., Matarrita, E.R. and Valverde, R.A. 2018. Discovery of a major east Pacific green turtle (Chelonia mydas) nesting population in Northwest Costa Rica. Chelonian Conservation Biology 17(2): 169–176.

31. Chacón-Chaverri, D., Martinez-Cascante, D.A., Rojas, D. and Luis Fonseca. 2014ª. Captura por unidad de esfuerzo y estructura poblacional de la tortuga verde de Pacífico (Chelonia mydas) en el Golfo Dulce, Costa Rica. Rev. Biol. Trop. (Int. J. Trop. Biol. ISSN-0034-7744) Vol. 63 (Suppl. 1): 363-373.

32. CIT. 2018. Análisis de datos de playas índices de anidación de la CIT (2009-2018) CIT-CC15-2018-Tec.14. Secretaría Pro Tempore CIT, Virginia USA.

33. Blanco, G.S., Morreale, S.J., Bailey, H., Seminoff, J.A., Paladino, F.V., and Spotila, J.R. 2012b. Post-nesting movements and feeding grounds of a resident east Pacific green turtle Chelonia mydas population from Costa Rica. Endangered Species Research 18:233–245.

34. HeideMeyer, M., R. Arauz-Aargas, and E. LóPez-Agüero. 2014. New foraging grounds for hawksbill (Eretmochelys imbricata) and green turtles (Chelonia mydas) along the northern Pacific coast of Costa Rica, Central America. Int. J. Trop. Biol. 62:109–118.

35. Heidemeyer, M., Delgado-Trejo; C., Hart, C., Clyde-Brockway, C., Fonseca, L., Mora, R., Mora, M. and Obando, R. 2018. Long-term In-water Recaptures of Adult Black Turtles (Chelonia mydas) Provide Implications for Flipper Tagging Methods in the Eastern Pacific. Herpetological Review, 2018, 49(4), 653–657.

36. Hart, C.E., Blanco, G.S., Coyne, M.S., Delgado-Trejo, C., Godley, B.J., Jones, T.T., Resendiz, A., Seminoff, J.A., Witt, M.J. and Nichols, W.J. 2015. Multinational tagging efforts illustrate regional scale of distribution and threats for East Pacific green turtles (Chelonia mydas agassizii). PLoS ONE 10, e0116225.

37. Bernardo and Plotkin 2007. In: Plotkin PT (ed) Biology and conservation of ridley sea turtles. An evolutionary perspective on the arribada phenomenon and reproductive behavioral polymorphism of olive ridley sea turtles (Lepidochelys olivacea). In: Plotkin PT (ed) Biology and conservation of ridley sea turtles. The John's Hopkins University Press, Maryland, pp 59–87.

38. Valverde, R.A., Cornelius, S.E., and Mo, C.L. 1998. Decline of the olive ridley sea turtle (Lepidochelys olivacea) nesting assemblage at Nancite beach, Santa Rosa National Park, Costa Rica. Chelonian Conservation and Biology 3:58–63.

39. Honarvar; S; O'Connor, M.P and James R. Spotila. 2008. Density-dependent effects on hatching success of the olive ridley turtle, Lepidochelys olivacea. Oecologia (2008) 157:221–230.

40. Fonseca, L.G., Murillo, G.A., Guadamúz, L., Spínola, R.M., Valverde, R.A. 2009. Downward but stable trend in the abundance of arribada olive ridley (Lepidochelys olivacea) sea turtles at Nancite Beach, Costa Rica for the period 1971-2007. Chelonian Conservation and Biology, 8(1):19-27.

41. Orrego, C. M., Rodríguez, N. 2017. The possitive relationship between the Ostional community and the conservation of olive ridley sea turtles at Ostional National Wildlife Refuge, Costa Rica. In Weatlund, L.; Charles, A.;Garcia, S.; Sanders, J. (eds). 2017. Marine Protected Areas: Interactions with fishery livelihoods and food security. FAO Fisheries and Aquaculture Technical Paper No. 603.Rome, FAO.

42. Valverde,R.A; Orrego,C.M.;Tordoir, M.T.; Gómez, F.M.; Solís,D.S.; Hernández, R.A.;Gómez, G.B.; Brenes, L.S.; Baltodano, J.P.; Fonseca, L.G. and James R. Spotila. 2012. Olive Ridley Mass Nesting Ecology and Egg Harvest at Ostional Beach, Costa Rica. Chelonian Conservation and Biology, 11(1):1-11. 2012.

43. Cornelius, S.E., Arauz, R., Fretey, J., Godfrey, M.H., Marquez-M., R., and Shanker, K. 2007. Effect of land basedharvest of Lepidochelys. In: Plotkin, P.T. (Ed.). The Biology and Conservation of Ridley Sea Turtles. Baltimore: Johns Hopkins University Press, pp. 231–251.

44. Plotkin, P.T., Briseno-Duenas, R., Abreu-Grobois, F.A., 2012. Interpreting signs of olive ridley recovery in the eastern Pacific. In: Seminoff, J.A.,Wallace, B.P. (Eds.), Sea Turtles of the Eastern Pacific. Advances in Research and Conservation. University of Arizona Press, Tucson, Arizona, pp. 302–335.

45. Dornfeld, T.C., Robinson, N.J., Santidrian Tomillo, P., and Paladino, F.V. 2015. Ecology of solitary nesting olive ridley sea turtles at Playa Grande, Costa Rica. Marine Biology 162:123-139.

46. Plotkin P. 2010. Nomadic behaviour of the highly migratory olive ridley sea turtle Lepidochelys olivacea in the eastern tropical Pacific Ocean. Endangered Species Research 13:33-40.

47. Bezy, V.S., Valverde, R.A. and Plante, C. J. 2015. Olive Ridley Sea Turtle Hatching Success as a Function of the Microbial Abundance in Nest Sand at Ostional, Costa Rica. PLoS ONE 10(2): e0118579.doi:10.1371/journal.pone.0118579.

48. Whoriskey, S., Arauz, R., Baum, J.K. 2011. Potential impacts of emergingmahi-mahi fisheries on sea turtle and elasmobranch bycatch species. Biol. Conserv. 144, 1841–1849.

49. Dapp, Derek; Arauz, Randall;Spotila, J. and O´Connor, M., 2013. Impact of Costa Rican longline fishery on its bycatch of sharks, stingrays, bony fish and olive ridley turtles (Lepidochelys olivacea). Journal of Experimental Marine Biology and Ecology 448 (2013) 228–239.

50. Swimmer, Y., Arauz, R., McCracken, M., Ballestero, J., Musyl, M., Bigelow, K., Brill, R., 2006. Dive behavior and delayed mortality of olive ridley Lepidochelys olivacea sea turtles after their release from longline fishing gear in the Eastern Tropical Pacific Ocean. Mar Ecol Prog Ser 323: 253–261.

51. Gaos, A.R., Abreu-Grobois, F.A., Alfaro-Shigueto, J., Amorocho, D., Arauz, R., Baquero, A., Briseño, R., Chacón, D., Dueñas, C., Hasbún, C., Liles, M., Mariona, G., Muccio, C., Muñoz, J.P., Nichols, W.J., Peña, M., Seminoff, J.A., Vásquez, M., Urteaga, J., Wallace, B., Yañez, I.L., And Zárate, P. 2010. Signs of hope in the eastern Pacific: international collaboration reveals encouraging status for the once-triaged hawksbill turtle. Oryx 44:595–601.

52. Chacón-Chaverri, D., Martínez-Cascante, D. A., Rojas, D., and Fonseca, L.G. 2014b. Golfo Dulce, Costa Rica, un área importante de alimentación para la tortuga carey del Pacífico Oriental (Eretmochelys imbricata). Rev. Biol. Trop. (Int. J. Trop. Biol. ISSN-0034-7744) Vol. 63 (Suppl. 1): 351-362.

53. Carrión-Cortés, J., Canales-Cerro, C., Arauz, R., and Riosmena- Rodríguez, R. 2013. Habitat Use and Diet of Juvenile Eastern Pacific Hawksbill Turtles (Eretmochelys imbricata) in the North Pacific Coast of Costa Rica.Chelonian Conservation and Biology, 2013, 12(2): 235–245.

54. Heidemeyer, M. 2014. Orígenes natales y migratorios de la agregación de tortuga negra (Chelonia mydas agassizii) en el hábitat de alimentación de la Isla del Coco basado en análisis de ADN, bioquímicos y tecnología satelital. MSc. Thesis. Universidad de Costa Rica, San Pedro, San Jose, Costa Rica.

55. Heidemeyer, M., Muñoz, J.P., Alarcón, D., Miranda, C., Chaves,J., Sánchez, D., Caballero, S., Chacón, D., Amorocho, D., Chavarría, M.M., Hart, C., Arauz, R., Albertazzi, F.J., Putman, N., Jensen, M,P., Abreu-Grobois, F. A., 2017. Breaching the Eastern Pacific Barrier: insights provided by regional

abundance patterns of the yellow green turtles in Eastern Pacific foraging grounds, 37th Annual Symposium on Sea Turtle Biology and Conservation, Las Vegas, USA, 15 - 20 April 2017. Memoria en Preparación.

56. Heidemeyer et al. 2016. Where do all these turtles come from? Low genetic diversity of Eastern Pacific hawksbill turtles (Eretmochelys imbricata) foraging in the Northern Pacific of Costa Rica demands new molecular approaches to determine origins at different habitats along Northern Pacific of Costa Rica", 36th Annual Symposium on Sea Turtle Biology and Conservation, Lima, Peru, 29 February - 4 March 2016. Memoria en preparación.

57. Santidrian-Tomillo, P., V.S. Saba, R. Piedra, F.V. Paladino & J.R. Spotila. 2008. Effects of illegal harvest of eggs on the population decline of leatherback turtles in Las Baulas Marine National Park, Costa Rica. Conserv. Biol., 22: 1216-1224.

58. RVS-PHPM-ACOPAC.2012. Refugio Nacional de Vida Silvestre Playa Hermosa-Punta Mala:Plan de Manejo 2013-2018-Diagnóstico 2012. Refugio Nacional de Vide Silvestre Playa Hermosa-Punta Mala-Área de Conservación Pacífico Central (ACOPAC).Aguirre-Costa Rica. 104 pp.

59. Wallace, B.P., Seminoff, J.A., Kilham, S.S., Spotila, J.R., and P. Dutton. 2006. Leatherback turtles as oceanographic indicators: stable isotope analyses reveal a trophic dichotomy between ocean basins. Marine Biology (2006) 149: 953–960.

60. Crim, J.L., Spotila, L.D., Spotila, J.R., O´Connor, M., Reina, R., Williams, C.J., and F. Paladino. 2002. The leatherback turtle, Dermochelys coriacea, exhibits both polyandry and polygyny. Molecular Ecology (2002) 11, 2097–2106.

61. Morreale, S. J., E. A. Standora, J. R. Spotila, and F. V. Paladino. 1996. Migration corridor for sea turtles. Nature 384:319–320.

62. Price, E.R., Wallace, B.P., Reina, R.D., Spotila, J.R., Paladino, F.V., Piedra, R., Vélez, E. 2004. Size, growth, and reproductive output of adult female leatherbacks Dermochelys coriacea.
Endang Species Res 1:41–48 (previously ESR 5:1–8), doi: 10.3354/esr001041.

63. Robinson, N.J., Dornfeld, T.C., Butler, B.O., Domico, L. J., Hertz, C. R., McKenna, L. N., Neilson, C.B., and S. A. Williamson. 2016. Plastic Fork Found Inside the Nostril of an Olive Ridley Sea Turtle. Marine Turtle Newsletter 150: 1-3.

64. Robinson, N.J., Valentine, S.E., Santidrian Tomillo, P., Saba, V. S., Spotila, J.R., and F. P.V. Paladino. 2014. Multidecadal trends in the nesting phenology of Pacific and Atlantic leatherback turtles are associated with population demography. Endang Species Res 24: 197–206.

65. Roe, J. H., Sill, N. S., Columbia, M. R., and F.V. Paladino. 2011. Trace Metals in Eggs and Hatchlings of Pacific Leatherback Turtles (Dermochelys coriacea) Nesting at Playa Grande, Costa Rica. Chelonian Conservation and Biology, 2011, 10(1): 3–9.

66. Santidrian Tomillo P, Saba VS, Lombard CD, Valiulis JM, Robinson NJ, Paladino FV, Spotila JR, Fernández C, Rivas ML, Tucek J, Nel R., Oro, D. 2015. Global analysis of the effect of local climate on the hatchling output of leatherback turtles. Scientific Reports. 2015; 5: 16789.

67. Santidri!an Tomillo, P., M. Genovart, F. V. Paladino, J. R. Spotila, and D. Oro. 2015b. Climate change overruns temperature resilience in sea turtles and threatens their survival. Global Change Biology 21:2980–2988.

68. Saba, V.S., Shillinger, G. L., Swithenbank, A. M., Block, B. A., Spotila, J. R., Musick, J.A., and F.V. Paladino. 2008. An oceanographic context for the foraging ecology of eastern Pacific leatherback turtles: Consequences of ENSO. Deep-Sea Research I 55 (2008) 646–660.

69. Santidrian-Tomillo, P., V.S. Saba, R. Piedra, F.V.Paladino & J.R. Spotila. 2008. Effects of illegal harvest of eggs on the population decline of leatherback turtles in Las Baulas Marine National Park, Costa Rica.Conservation Biology 22: 1216–1224.

CHAPTER 6 PANAMA

Updated 2020

Rodrigo Donadi[1, 2]

[1] Proyecto Carey-Coiba. SENACYT, Edif. 205 Ciudad del Saber, Panamá, PANAMA
[2] WWF Colombia, Carrera 35 No. 4A-25, Cali, Valle, COLOMBIA

Table 1. Main biology and conservation aspects of sea turtles in Panama Pacific.

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*	Y	*1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 19, 20, 24, 25, 27*	Y	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 19, 20, 24, 25, 27	Y	*1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 19, 20, 24, 25, 27*
Pelagic foraging grounds	Y, JA, A	*6, 20, 29, 30, 31*	Y, JA	*6, 20, 29, 30, 31*	Y, J	6, 20, 29, 30, 31	Y	*6, 20, 29, 30, 31*
Benthic foraging grounds	Y	*12, 14, 15, 18, 20, 29*	Y	*12, 14, 15, 18, 20, 29*	Y	12, 14, 15, 18, 20, 29	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* - 38,000 nests (1999) : 31,000 nests (2000) Isla Cañas (1996) - Arribadas in the past 5000-12000 females, crashed in 2013, only La Barqueta Agricola (1986-2003) - 2165 total nests (avg. 166 p/y) Mata Oscura (2008 - 2020) - 120-160 nests avg. p/y							
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 (unpub.)	n/a	
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: Caretta caretta is mentioned in the literature, but no direct evidence found of sightings.

Table 2. Sea turtle nesting beaches in Panama Pacific.

Province	Beach	Protected Area	Species	Major Site	NGO presence	Available data	Nests/yr: 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	1986-2003 77 females avg/yr 2165 Total nests 1004 females counted 77,132 turtles hatches from 87303 eggs 74 % Emergence success	N =166 (1986-2003) species not spec., but other data indicate mainly *Lo*	23, 37	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	2019 (Jun - Nov) N = 74 - Lo and 1 - Cm 5,000 hatchlings / 82% emergence success / estimated eggs 6097 / avg. clutch size 81	75	33, 34	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> 30,000 eggs - Lo (90% hatching successs) Cm - 300 hatchlings reaeased (6 nests)	Lo - 300 Cm - 6 in 2020	17	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 <u>2019 - 2020 (jun - jun)</u> 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	120-160 -(Lo, Cm) 15-20 - Ei	2, 16, 20, 30, 33, 41, 43	7.454355	-80.923401	4400	100	1	B
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	<u>2019-2020</u> 80 nests relocated / 5,953 hatchlings released Site of major activity with sporadic monitoring by PN Cerro Hoya personnel on motor bike. -Nursery set up in 2019 Ei - observed nesting somewhat regularly		2, 20, 30, 33	7.366918	-80.90146	8800	100	2	B
Veraguas	Sandial		Dc, Lo	S/D	N			2	n/a	n/a				
Veraguas	El Gato		Dc, Cm, Lo, Ei	Y	N			2, 30	7.309076	-80.920422	650			
Veraguas	Varadero		Lo	S/D	N			2	7.289764	-80.924341	1240			
Veraguas	Naranjo		Lo	P	N			2	7.274560°	-80.922099°	900			
Veraguas	Restinguito		Lo*	S/D	N			2	7.222341°	-80.886913°	500			
Veraguas	Restingue		Dc*, Lo	S/D	N			2, 20	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 ^	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	2003 - 2009 (*Arribadas*) 2003 - 6000 females 2004 - 5000 females 2005 - 7000 females 2006 - 9000 females 2007 - 6000 females 2008 - 15,000 females 2009 - 9,000 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) 2016 - 2017 - 4345 nests 2019 - 2020 - 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	14,070 nests avg. p/y between 2016 - 2020 (does not include 2018)	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* 2019 - 2020 (Jun-Mar)		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°	-80.153996°	25000			
Coclé	Farallón		S/D	S/D	N			20	8.359760°	-80.131750°	3000			
Panama	Punta Chame		Lo	Y	Y		166	33	8.620614°	-79.732777°	13000			
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, Isla del Rey	ZEM Las Perlas	Cm, Lo	S/D	N			1, 8, 10, 20,	8.299996°	-78.966374°	1300			
Panama	Isletilla Coquito, Isla del Rey	ZEM Las Perlas	Cm, Lo	S/D	N			1, 8, 10, 20,	8.293436°	-78.959908°	900			
Panama	Grillo, Isla del Rey	ZEM Las Perlas	Cm, Lo	Y	N			1, 8, 10, 20,	8.283653°	-78.941738°	3500			
Panama	Playa Grande Norte (Playon), Isla del Rey	ZEM Las Perlas	Cm, Lo, Ei	Y	N	2014-2015 26 Cm nests between jan - may / 90% (in situ) hatiching success / avg. Clutch size 63		1, 8, 10, 20,	8.231463°	-78.920933°	800	n/a discon tinued	2	B
Panama	Playa Grande Sur, Isla del Rey	ZEM Las Perlas	Cm, Lo	S/D	N			1, 8, 10, 20,	8.226340°	-78.913646°	750			
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 Rey	ZEM Las Perlas	Cm, Lo	S/D	N			1, 8, 10, 20,	8.226535°	-78.897539°	200			
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 (La Tortuguera o Nispero), Isla del Rey	ZEM Las Perlas	Cm, Lo	Y	N	2014 - 2015 61 Lo nests Agosto - Febrero / hatching success 73% relocation / avg. clutch size 95		1, 8, 10, 20,	8.239158°	- 78.911259°	2000	n/a discon tinued	2	B
Panama	Mafafita, Isla del Rey	ZEM Las Perlas	Cm, Lo	S/D	N			1, 8, 20,	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 al noroeste, Isla Pedro Gonzales	ZEM Las Perlas	Cm, Lo	Y	N			8, 10, 20,	8.399503°	- 79.117176°	480			
Panama	Playa al medio oeste, Isla Pedro Gonzalez	ZEM Las Perlas	Cm, Lo	Y	N			8, 10, 20,	8.391985°	- 79.113993°	250			
Panama	Playa al suroeste, Isla Pedro Gonzalez	ZEM Las Perlas	Cm, Lo	S/D	N			8, 10, 20,	8.381789°	- 79.095554°	450			
Panama	Playa Principal, Isla Viveros	ZEM Las Perlas	Cm, Lo	N	N			8, 10, 20,	8.488914°	- 78.978355°	600			
Panama	Playas al Oeste, Isla Bayoneta ^	ZEM Las Perlas	Cm, Lo, Ei	Y	N			8, 10, 20,	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*

P (in Major site column) = high probability

S/D = no data available

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

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)	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. Organizations involved in sea turtle conservation and/or research.

Organizations on the ground	type	primary species	primary beaches	work carried out	Long term >5 years	start date
Dirección de Costas y Mares (**DICOMAR**) - Ministerio de Ambiente	Government in conjunction with other local and/or international organizations	*Lo*	RVS Isla Cañas	Monitoreo, Vivero	Y	2012
		Lo	Reserva biologica La Marinera	Monitoreo, Vivero, marcaje,	Y	
		Lo, Cm, Ei	Playa Cascajilloso	Monitoreo, Vivero, marcaje,	N	2019
		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	NGO	*Lo, Cm*	Playa Malena	Monitoring, nursery,	Y	2002
Reserva Ecologica Privada Los Panamaes	Privada	*Lo, Cm*	Los Panames, 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	NGO	*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)	NGO	*Lo, Cm, Ei*	Cambutal y la Cuchilla	Monitoring, nursery, flipper tags	Y	2010

Comité Ambiental de Alanje	NGO	*Lo, Cm*	RVS La Barqueta Agricola	Monitoring, nursery **Note: project no longer active*	n/a	1986-2005

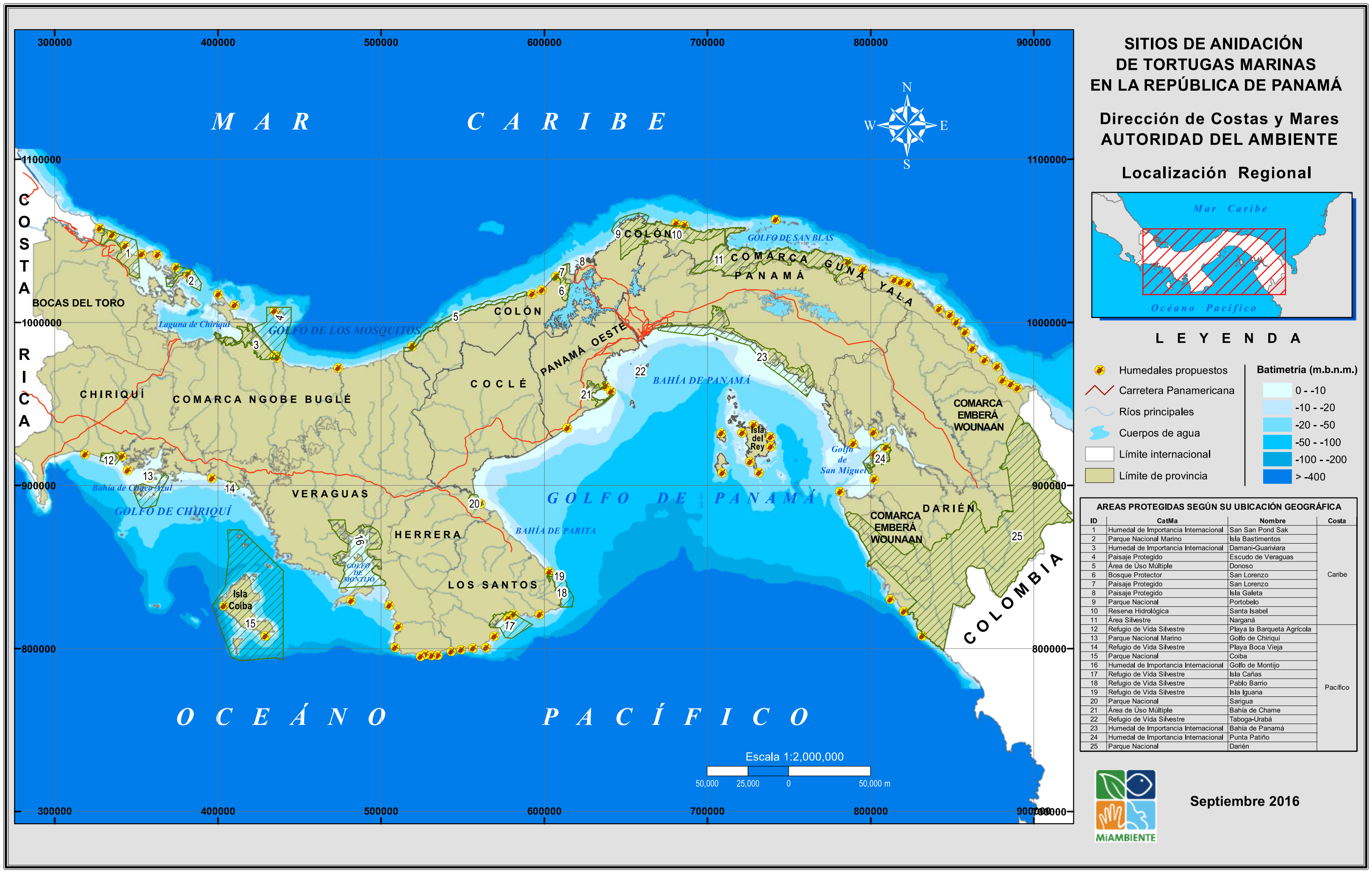


Figure 1a. Sea turtle nesting beaches in the Republic of Panama.

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.*

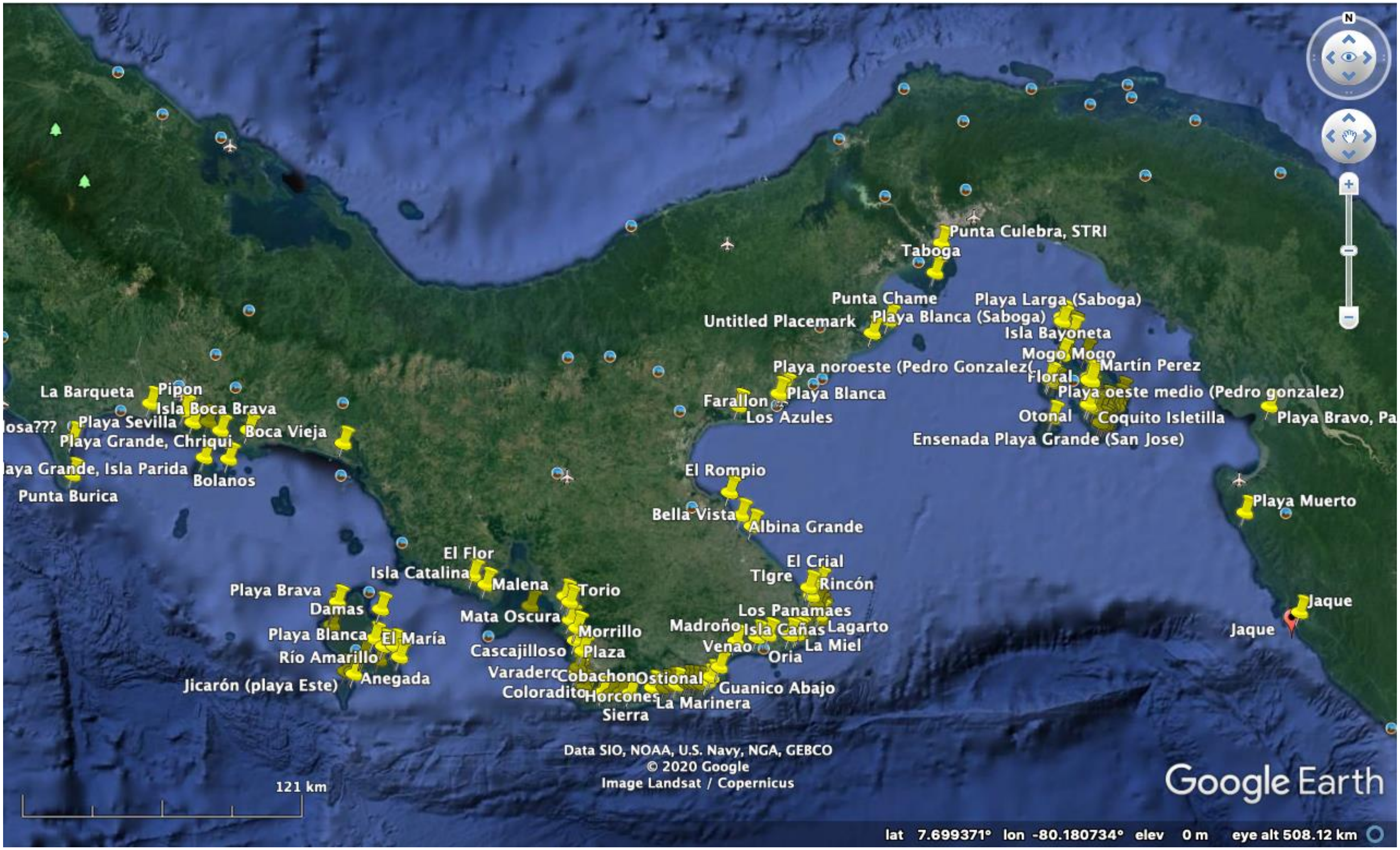


Figure 1b. Sea turtle nesting beaches in the Republic of Panama.

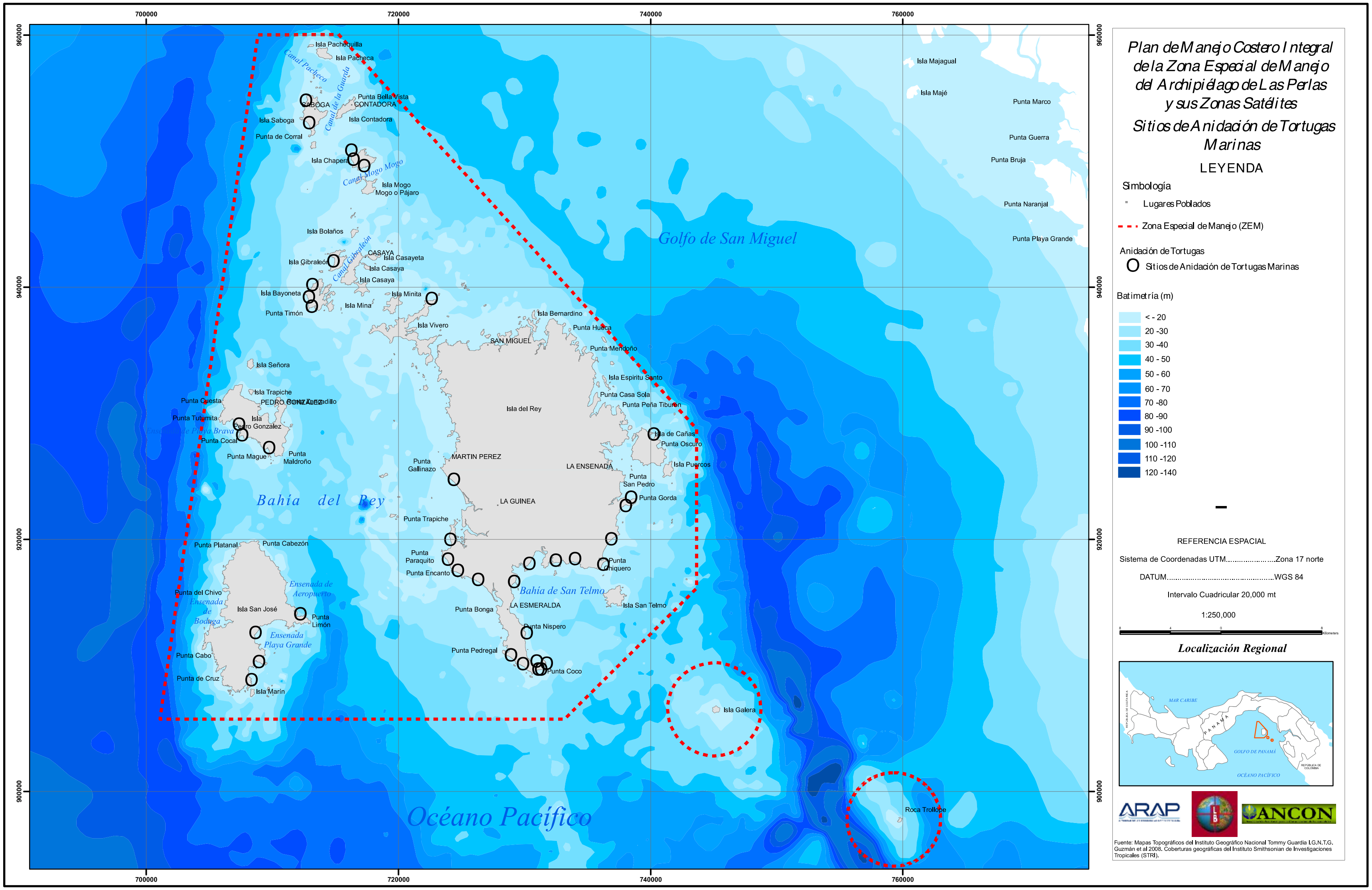


Figure 2. Sea turtle nesting beaches in the Special Management Zone (ZEM) of the Las Perlas Archipelago.

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.

References

1. Alvarez, G. (2015). Informe final de Proyecto Conservación de tortugas marinas en las playas de anidación de las Comunidades costeras de Cambutal y La Esmeralda. Tortuguías, Panamá.
2. Amorocho, D. (2018). Informe técnico finalReporte de la temporada de anidación de tortugas marinas en el Parque Nacional Cerro Hoya (Panamá) y Bahía Solano (Colombia). WWF - Programa de Especies para Latinoamérica y el Caribe".
3. Amorocho, D. (2016). Report of Systematic Monitoring of Sea Turtle Nesting in the Darien Gap-Choco region of Panama and Colombia. WWF / CIMAD / MiAmbiente.
4. Amorocho, D. (2018). Final Report Building capacity for community-based conservation of the Eastern Pacific Leatherback in the Darien Gap of Colombia and Panama. WWF / USFWS, December 10.
5. ANCON (1992). Evaluación Ecológica Rápida de la Reserva Natural Punta Patiño en Darién. (Citado en: Pinto_Marviva Diagnostico AMPs_2011).
6. Andraka, S. et al. (2013) Circle hooks: Developing better fishing practices in the artisanal longline fisheries of the Eastern Pacific Ocean. Biological Conservation 160 pp: 214-224.
7. ARAP (2011). Diagnóstico del Estado actual de las Tortugas Marinas en el Pacífico panameño. Informe de país, Panamá.
8. Consorcio Berger-ANCON (2011). Atlas de los recursos marino-costeros de la Zona Especial de Manejo del archipiélago de Las Perlas. ARAP.
9. Coudert, J. (2009). An assessment of sea turtles nesting sites in Las Perlas Archipelago, Panama. Tesis de M.Sc. Universidad Heriot-Watt, Edimburgo, Escocia.
10. Donadi, R. (2017) Caracterización rápida del estado de conservación y degradación de las playas de anidación de tortugas marinas en la Zona Especial de Manejo del Archipiélago de Las Perlas. PNUD Panamá.
11. Gaos, A. R., et al. (2017). Natal foraging philopatry in eastern Pacific hawksbill turtles." Royal Society open science 4.8: 170153.
12. Gaos, A. R., et al. (2018). Rookery contributions, movements and conservation needs of hawksbill turtles at foraging grounds in the eastern Pacific Ocean. Marine Ecology Progress Series 586 pp: 203-216.
13. Goarin, M. (2006). Monitoring and management of beaches in the archipelago of Las Perlas Panama. Tesis de M.Sc. Universidad Heriot-Watt, Edimburgo, Escocia.
14. Guzman, H. M., Benfield, S., Breedy, O., & Mair, J. M. (2008). Broadening reef protection across the Marine Conservation Corridor of the Eastern Tropical Pacific: distribution and diversity of reefs in Las Perlas Archipelago, Panama. Environmental Conservation, 35(1), 46-54.
15. Guzman, H. M., Guevara, C. A., & Breedy, O. (2004). Distribution, diversity, and conservation of coral reefs and coral communities in the largest marine protected area of Pacific Panama (Coiba Island). Environmental Conservation, 111-121.
16. https://www.laestrella.com.pa/cafe-estrella/destinoestrella/191010/191011-ruta-tortuga-encanto-preservacion http://fundat.net/quienes-somos-2/
17. https://www.telemetro.com/reportajes/2020/01/25/conservacion-de-tortuga-verde-en-playa-malena/2483296.html
18. Llamas, I. et al. (2017). Distribution, size range and growth rates of hawksbill turtles at a major foraging ground in the eastern Pacific Ocean. Latin american journal of aquatic research 45.3, pp: 585-596.
19. MiAmbiente (2017). Convención Interamericana para la Protección y Conservación de las Tortugas Marinas. Informe Anual 2016-2017, Panamá.

20. 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.
21. Pacheco Rovira, L. (2013). La pesca con palangre pelágico en el Pacifico panameño. Aspectos operativos de la selectividad de los anzuelos y repercusiones en la captura incidental de tortugas marinas. Tesis de Maestría, Universidad de Alicante. Departamento de Ciencias del Mar y Biología Aplicada.
22. Parga, M. L., et al. (2015). Hooking locations in sea turtles incidentally captured by artisanal longline fisheries in the Eastern Pacific Ocean. Fisheries Research 164 pp: 231-237.
23. Pinto, I.; Yee, J. (2011). Diagnóstico de las áreas marinas protegidas y de las áreas marinas para la pesca responsable en el Pacífico panameño. Fundación Marviva, Panamá, pp 215.
24. Rubio, M. (2009). Nesting beach characteristics of endangered sea turtles in Las Perlas Archipelago, Panama. Tesis de M.Sc. Universidad Heriot-Watt, Edimburgo, Escocia.
25. Ruíz A, Rodríguez J. (2011). Caracterización de las playas de anidación de tortugas marinas en el Parque Nacional Coiba, provincia de Veragüas, Panamá. Reporte Técnico. 139 p.
26. Seminoff, J. and Schumacher, J. (2016). Stable isotope values of hawksbill (Eretmochelys imbricata) shell material recovered from confiscated rooster spurs: a forensic approach to determining origin of turtles. NOAA NMFS-SFSC Stable Isotope Ecology Laboratory , La Jolla, California USA.
27. Vásquez-Bultrón, O.S. (2012). Evaluación de la densidad de nidos de tortuga lora (Lepidochelys olivacea), en la playa la Marinera, GuánicoAbajodeTonosí, ProvinciadelosSantos.Tesisde grado.UMIP. Panamá. 80 pp.
28. Vega, J. A. (2010). Diagnóstico del Impacto de la pesca artesanal sobre las tortugas marinas en el Archipiélago de las Perlas, Panamá. CEASPA.
29. Zarate, P. (2012). Offshore oasis. Ecology of sea turtles at oceanic islands of the eastern Pacific." Sea turtles of the eastern Pacific: Advances in research and conservation. Pp. 64-87.
30. Proyecto Carey-Coiba (2020). “Evaluación de la conectividad entre sitios de forrajeo y desove para la tortuga carey en el Parque Nacional Coiba y su zona de influencia". SENACYT - Convocatoria Fomento a la Investigación y Desarrollo 2017, (WWF FID17-114).
31. Plotkin, P. T. (2010). Nomadic behaviour of the highly migratory olive ridley sea turtle (Lepidochelys olivacea) in the eastern tropical Pacific Ocean. Endangered Species Res. 13, 33–40. doi: 10.3354/esr00314.
32. Vega, A. J., et al. (2015). Evaluación preliminar de la captura incidental de tortugas marinas por la pesquería artesanal del Golfo de Chiriquí. Tecnociencia 17.1 : 31-45.
33. "DICOMAR (2020). Información recabada de las acciones de los grupos comunitarios, OBC, ONG, e investigadores que desarrollan actividades de protección, conservación e investigación de tortugas marinas en el Pacífico y Caribe de Panama - Periodo 2019-2020. Abrgo, M."
34. Blas, J. (2020). Informe general de proyecto de conservación de tortugas marinas playa La Barqueta (2019-2020). Alianza ACOTOMAR, UNACHI, Familia Rojas.
35. Vega, A. & Y. Robles P. 2010. Captura incidental de tortugas marinas por la pesquería artesanal del Golfo de Chiriquí. Informe de Investigación. Universidad de Panamá-SENACYT-Marviva-Conservación Internacional.15 pp.
36. Garces, H.B; Bastista A.; y Sanchéz N. (2020) CARACTERIZACIÓN DE SITIOS DE ANIDACIÓN DE TORTUGAS MARINAS EN PLAYA LAGARTO, PEDASÍ, PROVINCIA DE LOS SANTOS, PANAMÁ. Tecnociencia, Vo.. 22, No. 2: 259-277.

37. CEPSA (2005). Plan de Manejo del RVS de la Barqueta Agrícola. ANAM. Pp: 163.
38. https://www.prensa.com/salud_y_ciencia/Nacen-artificiales-Cambutal-provincia-Santos_0_4706529306.html
39. Margaret Von Saeger - Panatortugas (2020). Personal communication.
40. MiAmbiente (2013). Convención Interamericana para la Protección y Conservación de las Tortugas Marinas. Informe Anual 2012-2013, Panamá.
41. https://www.laestrella.com.pa/cafe-estrella/planeta/190626/mata-oscura-paraiso-tortugas-anidacion
42. https://es.mongabay.com/2019/08/conservacion-de-tortugas-carey-en-panama/
43. Datos recolectados (2013-2019) por la Organización protectora de la tortuga marina y la biodiversidad de Jaque, proporcionados por Michelle Szejner (datos son propiedad de la organización).

CHAPTER 7 COLOMBIA

Updated 2019

Juan M. Rguez-Baron[1,2], Diego F. Amorocho[3], Jose T. Artuluaga Reales[4], Juan S. Ayala[5], Carlos Bejarano Rivas[4], Sandra Bessudo[6], José de la Cruz[4], Gustavo A. Lara[7], José A. Loaiza[8], Felipe Muriel Hoyos[8], Luis Payán[8], Eblin V. Pérez Castillo[4], Segundino Rivas[4], María E. Rivas Roa[4], Sixta T. Rivas Roa[4], Tomás Zapata Tejada[4], María X. Zorrilla Arroyave[8]

[1] JUSTSEA Foundation, Carrera 13 No. 152-80, Torre 1, 406, Bogotá, Colombia
[2] Biology and Marine Biology Department, University of North Carolina Wilmington, 601 S. College Road, Wilmington NC, 28403, USA
[3] Centro de Investigación para el Manejo Ambiental y el Desarrollo, Cali, Colombia
[4]Asociación Caguama, El Valle – Bahía Solano, Chocó, Colombia
[5]Centro de Investigación para el Manejo Ambiental y el Desarrollo CIMAD
[6]Fundación Malpelo y Otros Ecosistemas, Carrera 11 No. 87-51, Local 4, Piso 2, Bogotá, Colombia
[7]Direccion de Asuntos Marinos, Costeros y Recursos Acuaticos, Ministerio de Ambiente y Desarrollo Sostenible, Calle 37 No. 8-40, Bogotá, Colombia
[8]Parques Nacionales Naturales de Colombia, Dirección Territorial Pacífico, Calle 29 Norte No. 6N-43, Barrio Santa Mónica, Cali, Colombia

1. RMU *Lepidochelys olivacea*, Eastern Pacific Ocean (LO-EPO)

1.1. Distribution, abundance, trends

1.1.1. 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 National Natural Park (NNP) Utría, and represent the most important nesting rockery for the species at the South American Pacific [9]. The conservation activities started in 1991 by Fundación Natura that included the relocation of nests to in-situ hatcheries. This initiative was determinant for the protection of 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 of reproductive activities has been of special 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].

Other two important nesting sites and monitoring programs are located at NNP Gorgona and NNP Sanquianga. The Territorial Directorate of National Parks in the Pacific is in charge of monitoring 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 a systematic monitoring and taken relevant information on demographic aspects of females and hatchlings. The average of nests in this beach is 45.3 nests 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].

1.1.2. Marine areas

There is anecdotal information, mainly by fishermen, 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 individuals 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 (*Lepidochelis olivacea, Chelonia mydas*, *Eretmochelys imbricata*, and *Dermochelys coriacea*) [24].

1.2. 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], and a genotoxic biomarkers in erythrocytes was assessed at El Valle in 2017 [23].

2. RMU *Chelonia mydas*, Eastern Pacific Ocean (CM-EPO)

2.1. Distribution, abundance, trends

2.1.1. 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 a scarce nest in El Valle and Palmeras beaches (Table 2).

2.1.2. Marine areas

The Colombian Pacific is considered an area of importance as a feeding ground and for the development of green turtles. However, all the research on feeding ecology, and population structure has taken in PNN Gorgona. The study and protection of 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 an unexplored subject in Colombia.
hrough 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 (*Lepidochelis olivacea, Chelonia mydas*, *Eretmochelys imbricata*, and *Dermochelys coriacea*) [24].

2.2. Research

The Territorial Directorate of National Parks in the has developed a 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 the 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], genetic composition of the foraging population [4], and the intraspecific variation of two morphotypes [27].

3. RMU *Eretmochelys imbricata*, Eastern Pacific Ocean (EI-EPO)

3.1. Distribution, abundance, trends

3.1.1. Nesting sites

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

3.1.2. 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. Important data on size class of juveniles have been obtaining from a 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 (*Lepidochelis olivacea, Chelonia mydas*, *Eretmochelys imbricata*, and *Dermochelys coriacea*) [24].

3.2. Research

The Territorial Directorate of National Parks in the has developed a 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, were evaluated some ecological and biological features of the species, among the variables tested the authors assessed some biochemical features on blood samples [29].

4. RMU *Dermochelys coriacea*, Eastern Pacific Ocean (DC-EPO)

4.1. Distribution, abundance, trends

4.1.1. Nesting sites

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

4.1.2. Marine areas

There is anecdotal information, mainly by fishermen, about the use of neritic and oceanic habitats by *D. coriace* 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 individuals 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 (*Lepidochelis 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 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 of 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. It is known through interviews with fishermen that juvenile and adult turtles are caught by artisanal and industrial vessels, by multiple fishing gear.

8. 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 in development and foraging areas [37].

Colombia has signed several treaties that ensure the management and protection of sea turtles. Among these are 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 set forth 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.”

Table 1. Main biology and conservation aspects of sea turtles in the Colombian Pacific.

RMU								
	Lo	**Ref#**	**Cm**	**Ref#**	**Ei**	**Ref#**	**Dc**	**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	Tabl e2	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 the Colombian Pacific.

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. Organizations and agencies related with sea turtle research and conservation in the Colombian Pacific.

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

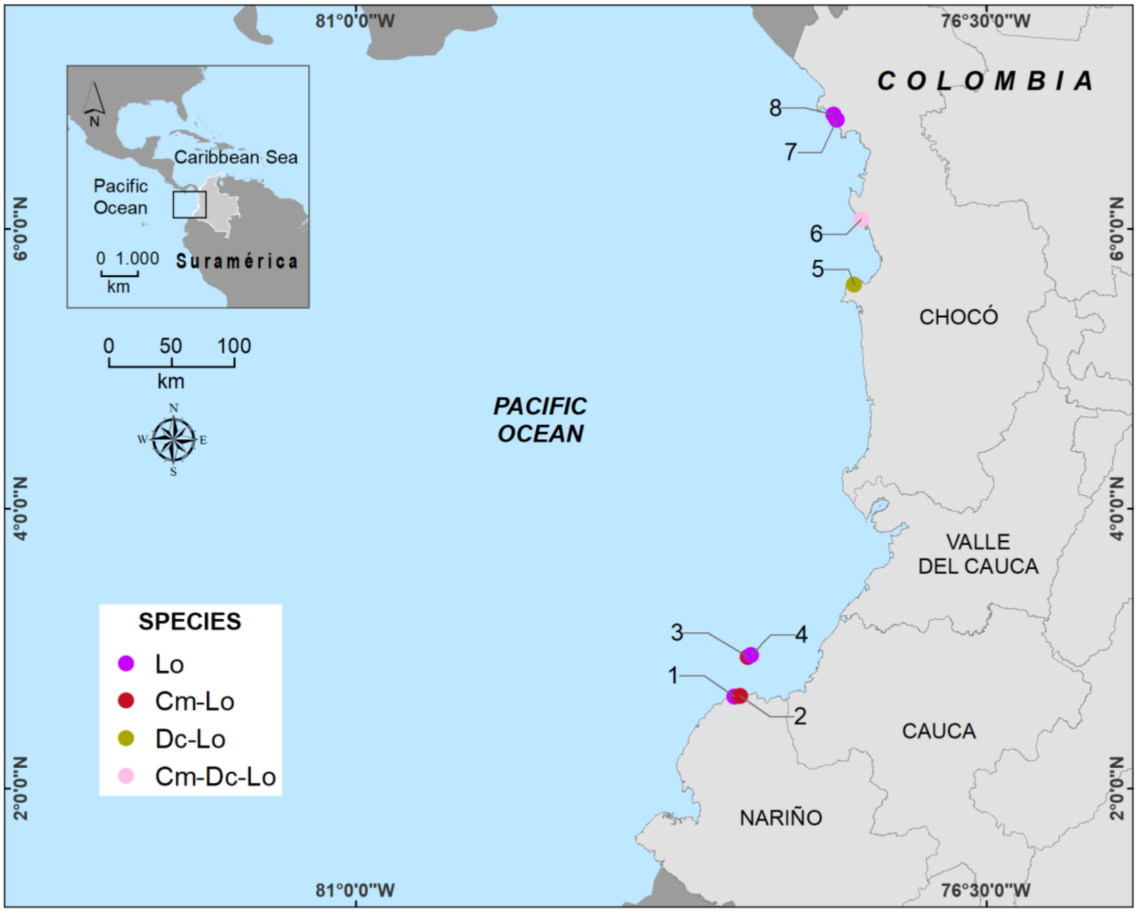


Figure 1. Biogeography and nesting beaches of sea turtles in the Colombian Pacific. 1 and 2. Los Mulatos, PNN Sanquianga, 3. PNN Gorgona, Palmeras, 4. PNN Gorgona, Playa Blanca, 5. Termales, 6. El Valle, 7. Chaguer, 8. Tortuguera.

REFERENCES

1. Alvarez-Varas, R, Berzins R, Bilo K, Chevalier J, Chevalier D, de Thoisy B, Fallabrino A, Garcia M, Kelez S, Kelle L, Lopez-Mendilaharsu M, Marcovaldi MA, Mast RB, Medrano C, Miranda C, Nalovic MA, Prosdocimi L, Rguez-Baron JM, Santos A, Soares L, Thome J, Vallejo F, Velez-Rubio G. 2016. Special Feature: Sea Turtle of South America. SWOT REPORT Vol. 11, pp. 16-27

2. Amorocho, D, RD Reina. 2007. Feeding ecology of the East Pacific green sea turtle Chelonia mydas at Gorgona National Park, Colombia. Endang Species Res. 3: 43-51.

3. Amorocho, D, RD Reina. 2008. Intake passage time, digesta composition and digestibility in East Pacific green turtles (Chelonia mydas) at Gorgona National Park, Colombian Pacific. Journal of Experimental Marine Biology and Ecology. 360: 117-124.

4. Amorocho, D, FA Abreu-Grobois, PH Dutton, RD Reina. 2012. Multiple distant origins for green sea turtles aggregating off Gorgona Island in the Colombian Eastern Pacific. PLos ONE. 7(2): e31486. doi:10.1371/journal.pone.0031486

5. Amorocho, D, Zapata LA. 2014. Guía de conservación y observación de tortugas marinas en los Parques Nacionales Naturales de Colombia. Ministerio de Ambiente y Desarrollo Sostenible y WWF-Colombia, 3ra ed. Cali, 20p.

6. Ayala Giraldo, JS. 2013. Informe final temporada de anidación de tortugas marinas en Playa Palmeras, Parque Nacional Natural Isla Gorgona, Pacífico colombiano. Parques Nacionales Naturales de Colombia. 25p.

7. Barreto Sánchez, LJ. 2011. Diagnóstico del estado actual de las tortugas marinas en el Pacífico colombiano. Informe de país. 71p.

8. Barrientos-Muñoz, KG, C Ramírez-Gallego, L Rivas. 2013. First report of nesting of black sea turtle (Chelonia mydas) on the North Pacific Coast of Colombia. Marine Turtle Newsletter. 138: 19-21.

9. Barrientos-Muñoz KG., Ramirez-Gallego C, Paez VP. 2014. Nesting ecology of olive ridley sea turtle (Lepidochelys olivacea) at El Valle beach, Northern Pacific, Colombia. Acta Biol Colomb. 19(3): 437-445.

10. Camacho-Mosquera, L, JD Palacio-Mejía, F Rondón-González. 2008. Caracterización genética de la colonia reproductiva de la tortuga marina golfina -Lepidochelys olivacea- en el Parque Nacional Natural Gorgona (Pacífico colombiano) a partir de secuencias de ADNmt. Bol. Invest. Mar. Cost. 37(1): 77-92.

11. Cubillos Pérez, DL. 2016. Características geomorfológicas de una playa potencial de anidación e identificación de las posibles amenazas para tortugas marinas en Puerto España, departamento del Valle del cauca. Tesis para optar al título de Bióloga. Pontifica Universidad Javeriana. Cali. 44p.

12. Gaos, AR, FA Abreu-Grobois, J Alfaro-Shigueto, D Amorrocho, R Arauz, A Baquero, R Briseño, D Chacón, C Dueñas, C Hasbún, M Liles, G Mariona, C Muccio, JP Muñoz, WJ Nichols, M Peña, JA Seminoff, M Vásquez, J Urteaga, B Wallace, IL Yañez, P Zárate. 2010. Signs of hope in the eastern Pacific: international collaboration reveals encouraging status for the severely depleted population of hawksbill turtles Eretmochelys imbricata. The International Journal of Conservation. doi:1017/s0030605310000773

13. Herrera Uribe, AE. 2011. Informe Final fortalecimiento del programa de monitoreo de tortugas marinas WWF - CIMAD -UAESPNN en el Paruqe Nacional Natural Gorgona, Temporada 2010-2011. 38p.

14. Hinestrosa, LM, V Páez. 2001. Anidación y manejo de la tortuga golfina (Lepidochelys olivacea) en la playa La Cuevita, Bahía Solano, Chocó, Colombia. Cuad. Herpetol. 14(2): 131-144.

15. Martínez LM, VP Páez. 2000. Nesting ecology of the olive ridley turtle (Lepidochelys olivacea) at La Cuevita, Chocoan Pacific Coast, Colombia, in 1998. Actual Biol. 22(73): 131-143.

16. Pavía, A, JA Rodríguez-Zuluaga,, DF Amorocho. 2006. Biología reproductiva de la rortuga caguama del Pacífico (Lepidochelys olivacea) en el parque Nacional Natural Gorgona-Colombia. Informe final presentado a National Fish and Wildlife Foundation (NFWF). CIMAD, Cali, Colombia. 34p.

17. Payán, LF, MX Zorrilla. 2012. Informe de Monitoreo de la temporada reproductiva de tortugas marinas en el PNN Gorgona julio 2011-febrero2012. 8p.

18. Payán, LF. 2010. Fortalecimiento del programa de monitoreo de tortugas marinas CIMAD-UAESPNN en el parque nacional natural Gorgona. Informe final septiembre 21-febrero 14 de 2010. 38p.

19. Payán, LF. 2016. Fortalecimiento del programa de monitoreo de tortugas marinas en el parque nacional natural Gorgona. Informe agosto -diciembre 2016. 13p.

20. Plan Nacional de las especies migratorias. Diagnóstico e identificación de acciones para la conservación y el manejo sostenible de las especies migratorias de la biodiversidad en Colombia. 2009. LG Naranjo, JD Amaya Espinel (eds). 214p.

21. Plan de manejo Parque Nacional Natural Gorgona 2018-2023. 2018. Parques Nacionales Naturales de Colombia Dirección Territorial Pacífico. 203p.

22. Ministerio del Medio Ambiente de Colombia. 2002. Programa Nacional para la Conservación de las Tortugas Marinas y Continentales de Colombia. Imprenta Nacional, Bogotá, Colombia; 63 p.

23. Quiroz Herrera, VH, J Palacio Baena. 2017. Genotoxic biomarkers in Erythrocytes of Lepidochelys olivacea (Cheloniidae) from Colombia. Acta Biol. Colomb. 22(3): 322-330.

24. Rguez-Baron, JM, A DiMatteo, A Bessudo, D Caicedo-Herrera, F Trujillo, C Becerra. 2017. Sightings of sea turtles in Colombian offshore waters through opportunity platforms. Abstact for 37 International Sea Turtle Symposium. Las Vegas NE.

25. Rodríguez-Zuluaga, JA. 2007. Fortalecimiento del Programa de Monitoreo de tortugas marinas en el Parque Nacional Natural Gorgona, Pacífico colombiano. Informe Final de actividades periodo 15 de mayo a 28 de agosto de 2007. 54p.

26. Rodríguez-Zuluaga, JA. 2008. Fortalecimiento del Programa de Monitoreo de tortugas marinas en el Parque Nacional Natural Gorgona, Pacífico colombiano. Informe Final de actividades periodo septiembre 2007-febrero 2008. 54p.

27. Sampson, L, Payán LF, Amorocho DF, Seminoff JA, Giraldo A. 2014. Intraspecific variation of the green turtle, Chelonia mydas (Cheloniidae), in the foraging area of Gorgona Natural National Park (Colombian Pacific). 19(3): 461-470.

28. Sampson, L, Giraldo A,Payán LF, Amorocho DF, Ramos MA, Seminoff JA, . 2017. Trophic ecology of green turtle Chelonia mydas juveniles in the Colombian Pacific. Journal of the Marine Biological Association of the United Kingdom. Doi:10.1017/S0025315417001400.

29. Tobón-López, A, DF Amorocho. 2014. Population study of the howksbill turtle Eretmochelys imbricata (Cheloniidae) in the Southern Pacific region of Colombia. Acta Biol. Colomb. 19(3): 447-457.

30. Trujillo-Arias, N, DF Amorocho, D López-Álvarez, LM Mejía-Ladino. 2014. Phylogeographic relations of some feeding and nesting of hawksbill turtle rookeries in the Caribbean and Pacific of Colombia. 2014. Bol. Invest. Mar. Cost.43(1): 159-182.

31. Barrientos-Muñoz KG., Ramirez-Gallego C, Paez VP. 2015. Tortuga golfina Lepidochelys olivacea. Pp. 161-165. En: Morales-Betancourt, M. A., C. A. Lasso, V. P. Páez y B. Bock. 2015. Libro rojo de reptiles de Colombia (2015). Instituto de Investigacion de Recursos Biologicos Alexander von Humbold (IAvH), Universidad de Antioquia. Bogota, DC, Colombia.

32. Barrientos-Muñoz KG., Ramirez-Gallego C, Paez VP. 2015. Tortuga carey Eretmochelys imbricata. Pp. 145-149. En: Morales-Betancourt, M. A., C. A. Lasso, V. P. Páez y B. Bock. 2015. Libro rojo de reptiles de Colombia (2015). Instituto de Investigacion de Recursos Biologicos Alexander von Humbold (IAvH), Universidad de Antioquia. Bogota, DC, Colombia.

33. Paez VP, Ramirez-Gallego C, Barrientos-Muñoz KG. 2015. Tortuga verde Chelonia mydas. Pp. 169-172. En: Morales-Betancourt, M. A., C. A. Lasso, V. P. Páez y B. Bock. 2015. Libro rojo de reptiles de Colombia (2015). Instituto de Investigacion de Recursos Biologicos Alexander von Humbold (IAvH), Universidad de Antioquia. Bogota, DC, Colombia.

34. Ramirez-Gallego, C, Paez VP, Barrientos-Muñoz KG. 2015. Tortuga cana Dermochelys coriacea. Pp. 158-162. En: Morales-Betancourt, M. A., C. A. Lasso, V. P. Páez y B. Bock. 2015. Libro rojo de reptiles de Colombia (2015). Instituto de Investigacion de Recursos Biologicos Alexander von Humbold (IAvH), Universidad de Antioquia. Bogota, DC, Colombia.

35. Jiménez-Tello, P. 2017. Anidación de la tortuga caguama del Pacífico (Lepidochelys olivacea) en la playa entre veredas Mulatos y Vigía del PNN Sanquianga durante los años 2008 a 2015. En: P Jumenez-Tello (Ed). Informes técnicos de los principales monitoreos realizados en el Parque Nacional Natural Sanquianga. Parque Nacional Natural Sanquianga, Mulatos. 62-86.

36. Muriel Hoyos, F, Galindo Tarazona R. (Eds). 2018. Monitoreo de anidación de la tortuga caguama del Pacífico (Lepidochelys olivacea) en el PNN Sanquianga (2016-2017). Parques Nacionales Naturales de Colombia, Dirección Territorial Pacífico, Parque Nacional Natural Sanquianga. 22pp.

37. Rguez-Baron, JM, R Mast, G Lara, L Chasqui, JV Rodriguez. 2019. Analisis de las iniciativas nacionales, manejo de informacion y normativas para la conservacion efectiva de las tortugas marinas en Colombia. Memoirs of a Gremial Meting for 5th Colombian Congress of Zoology, Bogota, Colombia. 53-54.

38. Ceballos-Fonseca, C, L Martínez, D Quiroga. 2003. Distribución, amenazas y esfuerzos de conservación de las tortugas marinas en el Pacífico colombiano. Informe final, INVEMAR, Santa Marta, Colombia. 78p.

39. Turner Tomaszewicz, CN, JA Seminoff, L Avens, LR Goshe, Juan M. Rguez-Baron, SH Peckham, Carolyne M. Kurle. 2018. Expanding the coastal forager paradigm: long-term pelagic habitat use by green turtles Chalonia mydas in the eastern Pacific Ocean. Mar Ecol Prog Ser. 587: 217-234.

40. Rguez-Baron, JM, A Williard, ME Abrego, A Tobon, D Bermudez, Y Arriatti. 2018. Building bycatch solutions from the ground up for the east pacific leatherback. SWOT Vol. 13, 36-37.

CHAPTER 8 ECUADOR

Updated 2019

Cristina Miranda[1]

[1]Fundación Equilibrio Azul, Av. Amazonas 2915 e Inglaterra, Edificio Inglaterra, 2nd floor. Quito, Ecuador

General Remarks

The state of Ecuadorian sea turtles, except for the Galapagos Islands, was completely unknown, except for some very few and superficial reports on nesting and stranding events. During the last 10 years this has changed as long-term research and conservation projects have settled along the continental coast, and Galapagos, making incredible advances in sea turtle research, such a re-discovering species that were thought to have disappeared, and in conservation such as protecting the most important beaches for sea turtles along the coast.

Added to this, the Ministry of Environment created a National Sea Turtle Plan (Plan Nacional de Tortugas Marinas) with the purpose of creating a monitoring program along the coast to protect as much nests and learn from the information gathered to contribute to their conservation (62). As a result, all the coastal and marine reserves in Ecuador have a sea turtle monitoring program, collaborate with international agreements such as the IAC, IATTC, Lima Convention, CMS, CITES, etc., and are constantly looking for new was to contribute to sea turtle conservation such as creating biological corridors through the Ministry's Subsecretaría de Gestión Marino with collaboration of local NGOs and universities (61).

There is still a long road ahead for sea turtle research and conservation in Ecuador.

1. RMU *Caretta caretta*, Eastern Pacific Ocean (CC-EPO)

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

Loggerhead sea turtles (*Caretta caretta*) have only been registered in Ecuadorian waters through an analysis of the Inter American Tropical Tuna Commission (IATTC) observers' data, collected between 1993-2002, where 383 sightings of loggerheads interacting with the fishery were reported. The locations of these records are at pelagic waters, close to the Galapagos Islands and very few close to continental Ecuador (34). The presence of this specie is occasional.

1.2. Threats

1.3.1. Nesting sites

No nesting has been registered for this species in Ecuador.

1.3.2. Marine areas

Even thought there is not much information about this specie in Ecuador, the only records are from industrial fishery interactions and by-catch from the IATTC on board observer's data. Therefore, the main threat for this specie is by-catch by fishing fleets in pelagic waters with long-lines, or purse seine. Alava, J. J. also reports mortality of loggerhead sea turtles associated to "floating objects" and fishing gear (34).

Only one report of a stranded loggerhead, in 2017, has been registered in Ecuador since the marine-protected areas and the Ministry of Environment rangers and volunteers started monitoring nesting beaches (61).

1.3. Conservation

There are no research or conservation programs taking place in Ecuador for this species in particular. However, Ecuador's legislation protects all species of sea turtles, it is a member of the IAC, IATTC, and Lima Conventions. The use of circled hooks has been promoted but not enforced. By-catch in industrial fisheries is of concern, but an even greater concern is artisanal fisheries by-catch as it is not quantified or monitored.

1.4. Research

There is an enormous gap in knowledge regarding this species. Its presence is confirmed in Ecuadorian waters, however there is no data regarding its abundance, distribution or conservation. The only existent data is 15 years old; a more recent analysis of the IATTC observers' data is necessary.

2. RMU *Chelonia mydas*, Eastern Pacific Ocean (CM-EPO)

2.1. Distribution, abundance, trends

2.1.1. Nesting sites

Green sea turtles are found nesting in continental Ecuador as well as in the Galápagos Islands. Abundance should be differenced between Galapagos Islands and continental Ecuador due to the high differences present.

In continental Ecuador they nest mostly in 15 beaches in the southern part of the coast, however only one index nesting site has been identified in Bahía Drake, La Plata Island, Machalilla National Park, with an average of 48 nests per year (13). At this site, between 2008-2013, a total of 81 nesting females were identified (50). Another index beach is hypothesized in Playa Dorada, a 300m long beach in a private reserve in Machalilla National Park's influence area, where an average of 12.7 nests per year have been reported between 2014-2016 (43), however further research is required to confirm the data of this site. In the remaining beaches, the average nests per year are between 1- 8.3 (1-15). Fig 1.

The Galápagos Islands are amongst the largest aggregation sites and nesting grounds for green sea turtle in the entire eastern Pacific with the highest abundance (45, 46, 48). There is nesting activity reported in almost the entire archipelago (47) but of sporadic nature; it is estimated that there are more than 100 nesting beaches (58), but the most important identified so far are Quinta Playa and Barahona Bay in Isabela Island, Las Bachas in Santa Cruz and Las Salinas in Bartolomé. Between 1999-2001 a total of 3790 nests were recorded in these 4 beaches (45). Since then, much of the research on nesting sea turtles is focused on Quinta Playa, Barahona Bay and Las Bachas due to the high nesting abundance these three beaches show with an average of 2769, 1726 and 613 nests respectively between 2009 and 2013, plus the nesting season of 2015 (10,11, 58). Other beaches of less abundance are also monitored (with less effort) such as the iconic Tortuga Bay in Santa Cruz Island where in 2015 46 nests were reported (11). There are some gaps in the latest nesting data; the data available for the nesting seasons 2013-2014 and 2015-2016 is incomplete (19, 26). Fig 2.

2.1.2. Marine areas

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

In continental Ecuador, the most important aggregation site for this species is La Plata Island in Machalilla National Park where, between 2008-2013, a total of 403 individuals were identified through capture-recapture (50). This specie is also associated to human activities; there is an aggregation of this species at Puerto López' port, where fish scraps attract green sea turtles and are observed feeding.

The Galápagos Islands represents one of the most abundant sites for green sea turtles in the eastern Pacific (47, 48, 75). The most important foraging grounds are Punta Espinoza, Bahia Elizabeth, Caleta Derek and Punta Nuñez, where between 2000-2008 a total of 1065 turtles were captured and tagged (69). More recently, in 2015, 623 green sea turtle individuals were identified in San Cristobal Island on just 3 sites and 35 boat surveys (52).

In terms of migration, four types of migratory patterns have been established for nesting green sea turtles from Galapagos: 1. Residents. 2. Migrating to Central America. 3. Migrating to the continent (South America). 4. Southwest oceanic migrations (48). Furthermore, a migratory connection 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 (40) and also through capture-recapture programs where one individual tagged at Isla de La Plata (continent) was observed nesting at Quinta Playa-Isabela, Galapagos (50).

The Galapagos Islands seems to be amongst the most important rookeries in the EP as it provides of turtles for foraging areas of the entire eastern Pacific and the main contributing rookery for green sea turtles in the South American eastern Pacific (57, 76-81).

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 human threats such as habitat destruction or artificial lights. Bahía Drake is the most important nesting site in continental Ecuador; it is a protected beach in Isla de la Plata-Machalilla National Park. However, nests there are threatened with sea level rise, as it is a very narrow beach. Nests have to be moved to a hatchery every season.

In other beaches, where even though the nesting activity for this specie 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 not only do thousands of visitors go every year, but public events from the Santa Cruz municipality have also taken place at this beach. 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 (68, 71).

2.3.2. Marine areas

Green sea turtles in Ecuador interact with fisheries; they are constantly attracted to boats, nets and longlines. A big amount of sea turtles at Isla de La Plata are observed with hooks and other injuries produced by fishing gear. The Marine Animal Rehabilitation Center of the Machalilla National Park (Centro de Rehabilitación de Fauna Marina del Parque Nacional Machalilla) constantly treats sea turtles with injuries from boat strikes and/or fishing gear (that are brought from all around the continental coast). Up to March 2017, the center had rehabilitated and released 103 sea turtles, however the species are no specified (51).

On both continental Ecuador and Galápagos green sea turtles are threatened by boat strikes (52). In 2014, the Charles Darwin Foundation reported that out of 1458 nesting females evaluated in Quinta Playa, 12% had injuries due to boat strikes (53).

In La Plata Island (continent) they are fed by tourism boats, possibly creating an association with boats and food, which could increase boat strikes and by-catch.

2.4. Conservation

Ecuadorian law protects this specie. Between 1994-1995 a total of 76 green sea turtle strandings due to trawling (83) and more recently a total 255 have been found straded (between 2014-2017) by the Ministry of Environment beach monitoring program (61). There are reports of by-catch with gillnets, long-line and trawling. The government as well as the IACCT have promoted the use of Turtle Exclusion Devices (TEDs) and circled hooks, however it is only a suggestion, not an obligation.

In continental Ecuador the Equilibrio Azul Foundation has research programs with this specie both in nesting beaches and in-water, as well as environmental education with children and fisherman. The ministry of environment with the Plan Nacional de Tortugas Marinas has a monitoring program in nesting beaches along the coast and protecting nests while working with local communities that live in or close to the nesting beaches (62). In Galápagos, the National Park has a monitoring program for two beaches: Las Bachas (Santa Cruz Island) and Quinta Playa (Isabela Island). The Galapagos Science Center (GSC) from San Francisco de Quito University San Francisco 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.

2.5. Research

Equilibrio Azul, the Galapagos Science Center-Proyecto Tortuga Negra from San Francisco de Quito University, and the Charles Darwin Foundation are the main entities researching this specie.

Much of the information that has been researched by the National Parks and/or by different NGOs since 2008 has not been published yet, both for Galápagos and for the rest of continental Ecuador. This research is focused on population dynamics and sizes, migratory patters, interaction with fisheries, boat strikes, the effects of ocean pollution on sea turtles, amongst other.

There is very important information from the observer programs from the government and/or the IACCT that is not readily available for the general public or scientific community, which should be easily available for researchers.

3. RMU *Eretmochelys imbricata*, Eastern Pacific Ocean (EI-EPO)

3.1. Distribution, abundance, trends

3.1.1. Nesting sites

Up until 2008, this species was thought to be extinct in Ecuador as well as in the entire eastern Pacific Ocean; there were very few reports of crawls on beaches that were thought to belong to this species, and few reports of by-catch (54). In 2008, La Playita in Machalilla National Park was found not only to host hawksbill nesting females, but to have important numbers of nests for such a diminished population (55). Since then 14 nesting beaches have been identified, 2 of them being index beaches, with more than 10 nests per km/year. These 2 beaches are La Playita in Machalilla National Park, south-central Ecuador with a mean of nearly 30 nests per year (1-3,35) and Playa Rosada (including the small adjacent beach of Chipi-Chipi; these two are only separated by a small patch of intertidal zone and the monitoring efforts are the same, so for the purpose of this report they are considered the same beach) in El Pelado Marine Reserve, south of Ecuador, with a mean of 41 nests per year (9, 17, 35, 44). Fig 3.

There is one more beach that requires further research, but is hypothesized to be of great importance for hawksbill sea turtles: Playa Dorada, a private reserve within the influence area of Machalilla National Park, that has reported only nearly 3 nests per year, but has not been monitored thoroughly and probably has a greater number of nests for these specie (43). Fig 3.

A total of 54 nesting females have been identified in Ecuador, 44 from Machalilla National Park, and 10 from El Pelado, with around 5 nesting each year in Machalilla Naitonal Park. Tagging efforts of females in Machalilla National Park are close to their saturation point (35).

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 (38). 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 (37-39,73, 74, 82, PS), on average they remigrate to their nesting ground in Machalilla National Park after 1.9 years (35). The only female tagged so far at Playa Rosada showed the same behavior (44). Some of the females tagged also visited and stayed at other reefs and rookeries such as Anconcito, south of Machalilla National Park, in Santa Elena province.

Neonate hatchlings have also been acoustically tracked, showing to migrate to pelagic waters, and 2 one-year old juveniles have been satellite tracked showing to migrate north to pelagic waters. This is an ongoing project (82).

This species has predominantly coastal behavior in continental Ecuador (36). Telemetry has also taken place in San Cristobal Island, Galapagos, showing no specific migratory patterns and staying within the Islands' reefs, close to shore (39).

Through capture-recapture, connectivity between the Galápagos Islands and continental Ecuador has also been confirmed; Equilibrio Azul captured a male hawkwbill in 2016 in Machalilla National Park that had originally been tagged as a juvenile in the Galapagos Islands by Patricia Zárate (PS).

Strandings and by-catch for this species are not common, which could be related to little abundance of this specie; the Ministry of Environment has reported a total of 11 stranded hawksbills between 2016-2017 (61).

3.2. Other biological data

An adult male hawksbill that was rehabilitated at Machalilla National Park's Rescue center, after being kept as a pet was found to have mangrove roots and seeds in his stomach (84).

3.3. Threats

3.3.1. Nesting sites

Nesting sites for hawksbill sea turtles are threatened mainly due to habitat destruction for development and artificial illumination. Despite the index beaches being inside protected areas, Playa Rosada in El Pelado Marine Reserve has been altered with the construction of tourism facilities, and there are plans for the construction of a big development right behind the beach. Development has increased artificial illumination and nest destruction, as well as access of invasive and destructive species such as feral and domestic dogs. Vegetation on beaches is often destroyed (burned or cut down); most hawksbills seek vegetation when nesting at La Playita (there is no vegetation left al Playa Rosada) (PS).

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 restricting access to this beach since 2008; however in 2016 a new tourist trail was opened to increase tourism in the area with an agreement with a local community (Salango). The creation of this trail has increased the number of people entering the beach during the day or illegally camping on it (with threats such as bonfires, dogs, and trash coming with it) even though access is now only allowed with a guide from the Salango community. The National Park has no resources to have Park rangers at this trail controlling the entrance and monitoring the beach. As a result in the 2016-2017 nesting season two hawksbill nests were stolen from the beach (PS).

Nesting beaches outside protected areas, or with communities living next to them, are threatened with destruction by development projects, sand extraction, vehicle entrance, artificial illumination, depredation by feral and domestic dogs and pigs, and illegal egg harvesting. In the past ten years a construction boom has taken place in the coast of Ecuador accelerating the destruction of habitat to build homes, hotels and government facilities and infrastructure (boardwalks), without rational management plans or zoning of beaches and nesting habitats.

Specifically, in the beach of Puerto López, a 2 km beach boardwalk was built on 2016 taking up to 16 meters of the width of the beach in some areas, making it less suitable for hawksbills sea turtles to nest. The boardwalk was illuminated with no regards towards nesting sea turtles. As a result, cars get in the beach to park during weekends and holidays on the southern part of the beach (the most suitable hawksbill habitat). Hawksbills have already been observed trying to nest next to the concrete walls of the boardwalk, people carrying the turtles when they've seen them on the beach and hatchlings going towards the illumination and dying. Sand extraction is also a big problem on this beach.

3.3.2. Marine areas

- Habitat destruction from infrastructure: As part of the construction boom in Ecuador in the last several years there has been several big scale artisanal fishing ports built, some of them in known rookeries for this specie and even inside Marine Protected Areas known to be the most important foraging ground for juveniles of this specie, such as in Machalilla National Park. Despite the protection that the Law gives to coral and rocky reefs, the special protection through IAT for hawksbill foraging habitat, and the special protection given to National Parks in Ecuadorian law, in 2017 a big artisanal fishing port was constructed in the southern limit of Puerto Lopez in a foraging ground for hawksbills.
- Habitat destruction from anchors (artisanal fishing boats and tourism boats)
- Overexploitation of reefs (even inside the protected areas) by artisanal fisherman.
- Shrimp trawling.
- Driftnets within foraging and aggregation areas, and especially inside protected areas.
- Pollution with fuel and oil spills (from industrial and artisanal fishing boats)
- Plastic, ghost nets, and fishing gear trash.
- By-catch and direct catch: there is a limited black market of hawksbill shell for artisanal jewelry and in (probably) a bigger scale for cock fighting spurs Further research is required to quantify the real impact of these markets.

3.4. Conservation

Hawksbill sea turtles are of particular interest considering their Critically Endangered status. Ecuador is also a signatory of the IAC that has a special issue on protecting hawksbill sea turtles and their habitats. Furthermore, Ecuador's legislation has coral reefs and mangroves under protection, thus protecting important hawksbill habitat.

-Protected under CITES, IAC and the Plan Nacional de Tortugas Marinas.
- Their most important nesting grounds are in protected areas: Machalilla National Park (the most important protected area in the coast) and El Pelado Marine Reserve.
-New marine reserves that connect both nesting grounds with their foraging areas are being established, such as the Machalilla-Cantagallo Marine Reserve: a reserve that will connect Machalilla National Park with El Pelado and will control and manage fisheries by banning large scale and industrial fisheries and specially trawlers.

There are 3 long-term projects taking place with this species: Ecuador Mundo Ecológico Foundation works in nesting beaches in El Pelado Marine Reserve. 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 in foraging areas in the Galapagos Islands. All three organizations are part of the Eastern Pacific Hawksbill Initiative, ICAPO, that seeks to reaserch.

Recommendations: it is important for the Ministry of Environment to work with NGOS and universities that are doing research by providing the information and using the information collected by researchers. Hawksbill shells are still observed in various towns and especially in cock-fighting pits. The construction of boardwalks on beaches should be reconsidered, banning any type of construction on beaches, including their vegetation zone, which is of most importance for hawksbills.

3.5. Research

There are several research projects in continental Ecuador and Galapagos working with hawksbill sea turtles. Also, the Eastern Pacific Hawksbill Initiative, through its local partners – Equilibrio Azul, Ecuador Mundo Ecológico and Galapagos Sciencie Center-Proyecto Tortuga Negra are doing long-term research.

There are still great knowledge gaps regarding this specie, especially in-water. There is data from 2008 on foraging grounds, migration and nesting that should be urgently published.

4. RMU *Dermochelys coriacea*, Eastern Pacific Ocean (DC-EPO)

4.1. Distribution, abundance, trends

4.1.1. Nesting sites

For a long time it was believed that this specie only used Ecuadorian waters, far away from the continent. This specie is scarce in Ecuador; very few nests have been registered in the last several years (one per year). There are 5 beaches where nesting has been reported, two of the nests were monitored, but none was successful. Fig 4

There is no more information regarding nesting or abundance of females for this specie.

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 Chilean (85).

However, there is also data from by-catch and interaction with fisheries for this specie in Ecuadorian waters, both close to the Galapagos Islands and close to continental Ecuador (59, PS). 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 bycatch using gillnets and longlines, placing Ecuador as a “high-bycatch zone”; other ports in the country were also identified to contribute to bycatch of this species such as Esmeraldas, Anconcito and Puerto Bolivar (86-87).

Anectotal data from artisanal fishermen seems to suggest that this species uses Ecuadorian waters constantly, and that there even seems to be presence of juveniles. Some fishermen have reported to have caught up to 4 juveniles leatherback turtles in one single set of gillnets (PS), however further research is required.

Stranding data from the Ministry of Environment have reported 5 stranded individuals since 2015 (61), plus one report by Equilibrio Azul (31) (Fig. 5).

4.3. Threats

4.3.1. Nesting sites

Although there is not much nesting activity for this specie in Ecuador, habitat destruction is still a threat for the very few nests reported. 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.

Some anecdotic nesting records for this specie reported leatherback turtles nesting against concrete walls with the tide crushing on to them in Same beach, Esmeraldas province (PS).

The few nests reported in the last 4 years have all been unsuccessful. There is no information available on the excavation of these nests, but anecdotical information suggests that all the eggs in one nest in San Lorenzo beach did not develop (8, 12, 27).

4.3.2. Marine areas

By-catch is the greatest threat for this specie in Ecuador (continental and Galapagos) The stranding information for this specie shows interaction with fisheries such as wounds on the anterior flippers.

4.4. Conservation

As with all other sea turtle specie, this specie 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.

The NFWF had a 10-year plan developed in 2013 for the conservation of the eastern Pacific leatherback population that included Ecuador, considering that it is a “high-by-catch zone”, with the objective to reduce by-catch of this species in the area (87).

Ecuadorian organizations, such as Equilibrio Azul are part of the LAUD OPO (Red Laud del Océano Pacífico Oriental) network that seeks to “protect, monitor and recover the east

Pacific leatherback" based on the "A 10-year plan to stabilize the East Pacific Leatherback Regional Management Unit and reverse the current population trend to a recovery trajectory" (87).

Equilibrio Azul has a project with artisanal fisherman to report any interaction with this specie (and any specie of sea turtles); in this project fisherman are the citizen scientists who take photos of the turtles, GPS points of the location of the turtles, if they can measure them, take DNA samples, and release them alive.

4.5. Research

There is a huge gap in knowledge about this specie in Ecuador, both in nesting activity as in water.

The only existent data comes from stranding events, few nests that were monitored by the Ministry of Environment of Ecuador, and fishery interaction from the IACCT and port-based surveys; all this information should be urgently published or made available to researchers working with this specie.

5. RMU *Lepidochelys olivacea*, Eastern Pacific Ocean (LO-EPO)

5.1. Distribution, abundance, trends

5.1.1. Nesting sites

This is the most abundant specie nesting in continental Ecuador with several index beaches as well as erratic nesting events found in the entire coast (PS).

Forty nesting beaches have been identified with constant nesting every year and which have monitoring efforts. Of these, 10 are index beaches, but further research is needed; there are many beaches from Ecuador that are not monitored or have never been monitored and that are potential nesting grounds for this specie. The most important nesting beaches are located in Manabí province, south-central Ecuador, in the Refugio de Vida Silvestre Pacoche (Pacoche Wildlife Reserve) and its surrounding areas with an average of 127 nests per year on its main beach, San Lorenzo, followed by 95 nests in La Botada beach, also within the reserve. In Esmeraldas province, north of Ecuador, Portete beach and Las Palmas are next in abundance with 77 and 88 nests per year, respectively. Fig. 6.

Research and beach monitoring is recent for most of continental Ecuador, especially for this species; probably as the monitoring efforts improve the number of nesting beaches and abundance will increase for this specie. Despite being the most abundant nesting specie, there is no data regarding number of females, remigration intervals, number of nests per female, etc. Most monitoring takes place through diurnal patrols.

5.1.2. Marine areas

No research has taken place in marine areas for this specie; 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 (83). The Ministry of Environment, through the beach monitoring program conducted by the Subsecretaría de Gestión Marino-Costera, has reported a total of 418 olive-ridley stranding events along the coast between 2014-2017 (61). It is also the most common specie at Machalilla National Park's Marina Fauna Rescue Center (84).

From a by-catch study conducted by Equilibrio Azul between 2009-2010, this specie was the one with the most interaction with long-line artisanal fisheries from the four species observed (green, hawksbill, leatherback and olive-ridley). A total of 92 olive-ridley sea turtles 'fell' in the long-line, representing 71% of all sea turtle bycatch during the study; the study had an effort of approximately one vessel per day. It is important to note that the study was conducted in pelagic waters, between 12 and 90 miles from the central coast of continental Ecuador. (59).

5.3. Threats

5.3.1. Nesting sites

The main threats for this species nesting sites are the following:

- Coastal development and artificial illumination
- Egg harvesting
- Climate change and rising seas
- Introduced animals such as feral and domestic dogs and pigs
- Removal of beach sand

The last two may be the biggest direct threats for 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 (30) and later by the Ministry of Environment of Ecuador. Other beaches such as Las Tunas, Manabi have around 40% of the nests destroyed by dogs (more research is required at this beach to have better estimates of nests per year and percentages of destruction (43). Most of the dogs that destroy nests in Ecuador are not feral but free roaming domestic pets. Furthermore coastal development is rapidly diminishing the available nesting habitats for this specie.

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 the Pacoche Wildlife Reserve have reduced the impact of this threat by establishing zones where the community can extract sand and no-extraction zones to protect nests.

The use and sale of sea turtles eggs is banned in Ecuador however when given the opportunity people harvest the eggs for self-consumption. The same goes for sea turtle meat and blood; if people happen to encounter sea turtles or their nests, they will make use of them, especially in beaches in the north of the country such as in Esmeraldas province (30, 31). This situation is very rare south of the country, but it has been reported in Las Tunas and in Playa Dorada, Manabi province (43).

5.3.2. Marine areas

The main threat in marine-areas for this species, based on stranding information and in the fact that the aggregation site is unknown, is by-catch and fishery interactions. A great percentage of the stranded olive ridleys are found with severe injuries on their skulls and carapace, possibly caused to avoid entanglement or to disentangle them from fishing gear (30, 31, 61, 84). On a series of surveys conducted to artisanal fisherman in Esmeraldas province during 2012, 83% admitted to hit turtles on the head with sticks to numb them in order to release them from the nets (30).

From a by-catch study conducted between 2009-2010, this specie was the one with the most interaction with long-line artisanal fisheries from the four species observed (green, hawksbill, leatherback and olive-ridley). A total of 92 olive-ridley sea turtles 'fell' in the long-line, representing 71% of all sea turtle bycatch during the study. It is important to note that the study was done in pelagic waters, between 12 and 90 miles from the central coast of continental Ecuador. (59).

5.4. Conservation

All sea turtles are protected in Ecuador. The main index beaches for this species are protected. San Lorenzo and La Botada were already part of the Pacoche Wildlife Reserve prior to sea turtle monitoring, but since they have a local community great effort have been put into environmental education and conservation. Portete beach was recently included as part of the Refugio de Vida Silvestre Manglares Estuario del Rio Muisne (Muisne River Estuary Wildlife Reserve) after evidencing the nesting abundance it has, however there are very limited resources for its real protection and nest destruction by dogs continues to be a problem.

Las Palmas beach is the main beach of the city of Esmeraldas, the biggest in northern Ecuador, and adjacent to the largest oil refinery of the country. The problems here are habitat destruction, artificial illumination, nest destruction and obstruction by human activities and sand removal. Research and nest protection on this beach are very recent and is conducted by the Ministry of Environment of Ecuador; their efforts have managed to protect a great percentage of the nests that this important beach holds, and environmental education with the local tourism is taking place.

5.5. Research

Despite this specie being the most abundant nesting in Ecuador, the information gathered is limited to number of nests. 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.

Table 1. Main biology and conservation aspects of sea turtles in Ecuador.

RMU	Eastern Pacific CC	Ref #
Occurrence		
Nesting sites	N	
Pelagic foraging grounds	Y	34
Benthic foraging grounds	N	
Key biological data		
Nests/yr: recent average (range of years)	n/a	
Nests/yr: recent order of magnitude	n/a	
Number of "major" sites (>20 nests/yr AND >10 nests/km yr)	n/a	
Number of "minor" sites (<20 nests/yr OR <10 nests/km yr)	n/a	
Nests/yr at "major" sites: recent average (range of years)	n/a	
Nests/yr at "minor" sites: recent average (range of years)	n/a	
Total length of nesting sites (km)	n/a	
Nesting females / yr	n/a	
Nests / female season (N)	n/a	
Female remigration interval (yrs) (N)	n/a	
Sex ratio: Hatchlings (F / Tot) (N)	n/a	
Sex ratio: Immatures (F / Tot) (N)	n/a	
Sex ratio: Adults (F / Tot) (N)	n/a	
Min adult size, CCL or SCL (cm)	n/a	
Age at maturity (yrs)	n/a	
Clutch size (n eggs) (N)	n/a	
Emergence success (hatchlings/egg) (N)	n/a	
Nesting success (Nests/ Tot emergence tracks) (N)	n/a	
Trends		
Recent trends (last 20 yrs) at nesting sites (range of years)	n/a	

Recent trends (last 20 yrs) at foraging grounds (range of years)	n/a	
Oldest documented abundance: nests/yr (range of years)	n/a	
Published studies		
Growth rates	N	
Genetics	N	
Stocks defined by genetic markers	N	
Remote tracking (satellite or other)	N	
Survival rates	N	
Population dynamics	N	
Foraging ecology (diet or isotopes)	Y	
Capture-Mark-Recapture	N	
Threats		
Bycatch: presence of small scale / artisanal fisheries?	N	34
Bycatch: presence of industrial fisheries?	Y (PLL, SN, BT)	34
Bycatch: quantified?	N	34
Take. Intentional killing or exploitation of turtles	N	
Take. Egg poaching	n/a	
Coastal Development. Nesting habitat degradation	n/a	
Coastal Development. Photopollution	n/a	
Coastal Development. Boat strikes	N	
Egg predation	n/a	
Pollution (debris, chemical)	n/a	
Pathogens	n/a	
Climate change	n/a	
Foraging habitat degradation	n/a	
Other	N	
Long-term projects		

Monitoring at nesting sites	N	
Number of index nesting sites	n/a	
Monitoring at foraging sites	N	
Conservation		
Protection under national law	Y	
Number of protected nesting sites (habitat preservation)	n/a	
Number of Marine Areas with mitigation of threats	n/a	
Long-term conservation projects (number)	n/a	
In-situ nest protection (eg cages)	n/a	
Hatcheries	n/a	
Head-starting	n/a	
By-catch: fishing gear modifications (eg, TED, circle hooks)	BT,PLL	
By-catch: onboard best practices	Y	
By-catch: spatio-temporal closures/reduction	N	
Other	N	
RMU	**Eastern Pacific CM**	Ref #
Occurrence		
Nesting sites	Y	1-15, 58
Pelagic foraging grounds	A	48, 56
Benthic foraging grounds	JA	48, 56, 64-67
Key biological data		
Nests/yrCONTINENT: recent average (range of years)	7.7 (2012-2017)	
Nests/yrGALAPAGOS: recent average (range of years)	1536.7 (2013-2016)	
Nests/yrCONTINENT: recent order of magnitude	1_48	
Nests/yrGALAPGAOS: recent order of magnitude	46-2769	
Number of "major" sites GALAPAGOS (>20 nests/yr AND >10 nests/km yr)	4	10, 11, 45, 58,
Number of "major" sites CONTINENT (>20 nests/yr AND >10 nests/km yr)	1	50

Number of "minor" sites GALAPAGOS (<20 nests/yr OR <10 nests/km yr)	100	45, 58
Number of "minor" sites CONTINENT (<20 nests/yr OR <10 nests/km yr)	14	1-15, 50
Nests/yr at "major" sitesCONTINENT: recent average (range of years)	30.3 (2011-2016)	50
Nests/yr at "major" sitesGALAPAGOS: recent average (range of years)	1536.7 (2013-2016)	58
Nests/yr at "minor" sitesCONTINENT: recent average (range of years)	0.0	1_15
Nests/yr at "minor" sitesGALAPAGOS: recent average (range of years)	n/a	
Total length of nesting sites (km) GALAPAGOS	#VALUE!	
Total length of nesting sites (km) CONTINENT	30.954	
Nesting females / yr CONTINENT	28.7	50
Nesting females / yr GALAPAGOS	2005	45, 58
Nests / female season (N)	2.3 (4769)	58
Female remigration interval (yrs) (N) GALAPAGOS	4.7 (884)	58
Female remigration interval (yrs) (N) CONTINENT	n/a	
Sex ratio: Hatchlings (F / Tot) (N)	n/a	
Sex ratio: Immatures (F / Tot) (N)	n/a	
Sex ratio: Adults (F / Tot) (N)	n/a	
Min adult size, CCL or SCL (cm)	69 cm	45
Age at maturity (yrs)	n/a	
Clutch size (n eggs) (N) GALAPAGOS	82.9 (3790)	45
Clutch size (n eggs) (N) CONTINENT	n/a	
Emergence success (hatchlings/egg) (N) GALAPAGOS	45.6 (1039)	71
Emergence success (hatchlings/egg) (N) CONTINENT	n/a	
Nesting success (Nests/ Tot emergence tracks) (N) GALAPAGOS	0.66 (16869)	58
Nesting success (Nests/ Tot emergence tracks) (N) CONTINENT	n/a	
Trends		
Recent trends (last 20 yrs) at nesting sites (range of years) GALAPAGOS	n/a	
Recent trends (last 20 yrs) at nesting sites (range of years) CONTINENT	n/a	
Recent trends (last 20 yrs) at foraging grounds (range of years) GALAPAGOS	n/a	

Recent trends (last 20 yrs) at foraging grounds (range of years) CONTINENT	n/a	
Oldest documented abundance: nests/yr (range of years)		
Published studies		
Growth rates	Y	69
Genetics	Y	40, 63, 70
Stocks defined by genetic markers	Y	70
Remote tracking (satellite or other)	Y	64,41, PS
Survival rates	N	
Population dynamics	Y	40, PS
Foraging ecology (diet or isotopes) GALAPAGOS	Y	64-67
Foraging ecology (diet or isotopes) CONTINENT	N	
Capture-Mark-Recapture	Y	58, 45, 69, PS
Threats		
Bycatch: presence of small scale / artisanal fisheries?	Y	59, 83
Bycatch: presence of industrial fisheries?	Y (PLL,DLL,SN,DN,ST,MT,PT)	
Bycatch: quantified?	N	
Take. Intentional killing or exploitation of turtles	N	
Take. Egg poaching	N	
Coastal Development. Nesting habitat degradation	Y	PS
Coastal Development. Photopollution	Y	PS
Coastal Development. Boat strikes	Y	52, 53
Egg predation	Y	68, 71
Pollution (debris, chemical)	Y	52
Pathogens	Y	42
Climate change	n/a	
Foraging habitat degradation	Y	PS
Other	Y	68

Long-term projects		
Monitoring at nesting sites	Y	PS
Number of index nesting sites	4	
Monitoring at foraging sites	Y	PS
Conservation		
Protection under national law	Y	62
Number of protected nesting sites (habitat preservation)	11	62
Number of Marine Areas with mitigation of threats	10	62
Long-term conservation projects (number)	6	
In-situ nest protection (eg cages)	Y	
Hatcheries	Y	
Head-starting	n/a	
By-catch: fishing gear modifications (eg, TED, circle hooks)	BT,PLL	
By-catch: onboard best practices	Y	
By-catch: spatio-temporal closures/reduction	N	
Other	N	
RMU	**Eastern Pacific EI**	Ref #
Occurrence		
Nesting sites	Y	1-5,9,14,16-20,44,35
Pelagic foraging grounds	J	82
Benthic foraging grounds	JA	1,2,4,36,37
Key biological data		
Nests/yr: recent average (range of years)	93.2 (n/a)	1-5,9,14,16-20,44,35
Nests/yr: recent order of magnitude	1-46	1-5,9,14,16-20,44,35
Number of "major" sites (>20 nests/yr AND >10 nests/km yr)	2	1-5, 9, 44
Number of "minor" sites (<20 nests/yr OR <10 nests/km yr)	12	1-5,9,14,16-20,44,35

Nests/yr at "major" sites: recent average (range of years)	70.7 (2015-2017)	1-5, 9, 44
Nests/yr at "minor" sites: recent average (range of years)	22.5 (n/a)	1-5,9,14,16-20,44,35
Total length of nesting sites (km)	19.62	1-4,16-20,35,43,44
Nesting females / yr	4.89	35
Nests / female season (N)	2.3(65)	35
Female remigration interval (yrs) (N)	1.9 (19)	35
Sex ratio: Hatchlings (F / Tot) (N)	n/a	
Sex ratio: Immatures (F / Tot) (N)	n/a	
Sex ratio: Adults (F / Tot) (N)	0.15	38
Min adult size, CCL or SCL (cm)	67cm	PS
Age at maturity (yrs)	n/a	
Clutch size (n eggs) (N)	159.1 (165)	35
Emergence success (hatchlings/egg) (N)	.597 (184)	35
Nesting success (Nests/ Tot emergence tracks) (N)	0.62(184)	35
Trends		
Recent trends (last 20 yrs) at nesting sites (range of years)	n/a	
Recent trends (last 20 yrs) at foraging grounds (range of years)	n/a	
Oldest documented abundance: nests/yr (range of years)	5(1996-1997)	60
Published studies		
Growth rates	Y	69
Genetics	Y	36, 72
Stocks defined by genetic markers	Y	72
Remote tracking (satellite or other)	Y	37, 38, 39,73, 74,82, PS
Survival rates	N	
Population dynamics	Y	35, PS
Foraging ecology (diet or isotopes)	Y	PS
Capture-Mark-Recapture	Y	PS

Threats		
Bycatch: presence of small scale / artisanal fisheries?	Y (SN,DN,ST,MT)	Equilibrio Azul PS
Bycatch: presence of industrial fisheries?	n/a	
Bycatch: quantified?	N	
Take. Intentional killing or exploitation of turtles	Y	PS
Take. Egg poaching	Y	PS
Coastal Development. Nesting habitat degradation	Y	PS
Coastal Development. Photopollution	Y	PS
Coastal Development. Boat strikes	Y	52
Egg predation	Y	31
Pollution (debris, chemical)	Y	PS
Pathogens	N	
Climate change	Y	
Foraging habitat degradation	Y	PS
Other	Y (see text)	PS
Long-term projects		
Monitoring at nesting sites	Y	PS, 61, 1-5, 44
Number of index nesting sites	2	1-5, 9, 44
Monitoring at foraging sites	Y	38
Conservation		
Protection under national law	Y	62
Number of protected nesting sites (habitat preservation)	9	62
Number of Marine Areas with mitigation of threats	2	62
Long-term conservation projects (number)	2	
In-situ nest protection (eg cages)	2	
Hatcheries	1	
Head-starting	N	

By-catch: fishing gear modifications (eg, TED, circle hooks)	BT,PLL	
By-catch: onboard best practices	N	
By-catch: spatio-temporal closures/reduction	N	
Other	Y (see text)	
RMU	**Eastern Pacific DC**	Ref #
Occurrence		
Nesting sites	Y	8, 12, 27
Pelagic foraging grounds	JA	PS
Benthic foraging grounds	N	
Key biological data		
Nests/yr: recent average (range of years)		
Nests/yr: recent order of magnitude		
Number of "major" sites (>20 nests/yr AND >10 nests/km yr)	0	
Number of "minor" sites (<20 nests/yr OR <10 nests/km yr)	5	8, 12, 27
Nests/yr at "major" sites: recent average (range of years)		
Nests/yr at "minor" sites: recent average (range of years)		
Total length of nesting sites (km)		
Nesting females / yr	n/a	
Nests / female season (N)	n/a	
Female remigration interval (yrs) (N)	n/a	
Sex ratio: Hatchlings (F / Tot) (N)	n/a	
Sex ratio: Immatures (F / Tot) (N)	n/a	
Sex ratio: Adults (F / Tot) (N)	n/a	
Min adult size, CCL or SCL (cm)	n/a	
Age at maturity (yrs)	n/a	
Clutch size (n eggs) (N)	n/a	
Emergence success (hatchlings/egg) (N)	n/a	
Nesting success (Nests/ Tot emergence tracks) (N)	n/a	

Trends		
Recent trends (last 20 yrs) at nesting sites (range of years)	n/a	
Recent trends (last 20 yrs) at foraging grounds (range of years)	n/a	
Oldest documented abundance: nests/yr (range of years)	n/a	
Published studies		
Growth rates	N	
Genetics	N	
Stocks defined by genetic markers	N	
Remote tracking (satellite or other)	N	
Survival rates	N	
Population dynamics	N	
Foraging ecology (diet or isotopes)	N	
Capture-Mark-Recapture	N	
Threats		
Bycatch: presence of small scale / artisanal fisheries?	Y (PLL, SN,DN)	
Bycatch: presence of industrial fisheries?	Y (PLL, SN, BT)	
Bycatch: quantified?	N	
Take. Intentional killing or exploitation of turtles	N	
Take. Egg poaching	N	
Coastal Development. Nesting habitat degradation	Y	
Coastal Development. Photopollution	Y	
Coastal Development. Boat strikes	N	
Egg predation	N	
Pollution (debris, chemical)	n/a	
Pathogens	n/a	
Climate change	N	
Foraging habitat degradation	N	

Other	N	
Long-term projects		
Monitoring at nesting sites	Y	
Number of index nesting sites	0	
Monitoring at foraging sites	Y	
Conservation		
Protection under national law	Y	
Number of protected nesting sites (habitat preservation)	0	
Number of Marine Areas with mitigation of threats	0	
Long-term conservation projects (number)	1	
In-situ nest protection (eg cages)	Y	
Hatcheries	N	
Head-starting	N	
By-catch: fishing gear modifications (eg, TED, circle hooks)	BT,PLL	
By-catch: onboard best practices	Y	PS
By-catch: spatio-temporal closures/reduction	N	
Other	N	
RMU	**Eastern Pacific LO**	Ref #
Occurrence		
Nesting sites	Y	
Pelagic foraging grounds	n/a	
Benthic foraging grounds	n/a	
Key biological data		
Nests/yr: recent average (range of years)	578 (2013-2017)	1-12,14,15,17,20,23-33,43
Nests/yr: recent order of magnitude	1_127	1-12,14,15,17,20,23-33,43

Number of "major" sites (>20 nests/yr AND >10 nests/km yr)	10	1-12,14,15,17,20,23-33,43
Number of "minor" sites (<20 nests/yr OR <10 nests/km yr)	30	1-12,14,15,17,20,23-33,43
Nests/yr at "major" sites: recent average (range of years)	50.2 (2013-2017)	1-12,14,15,17,20,23-33,43
Nests/yr at "minor" sites: recent average (range of years)	2.5 (2013-2017)	1-12,14,15,17,20,23-33,43
Total length of nesting sites (km)	#VALUE!	1-12,14,15,17,20,23-33,43
Nesting females / yr	n/a	
Nests / female season (N)	n/a	
Female remigration interval (yrs) (N)	n/a	
Sex ratio: Hatchlings (F / Tot) (N)	n/a	
Sex ratio: Immatures (F / Tot) (N)	n/a	
Sex ratio: Adults (F / Tot) (N)	n/a	
Min adult size, CCL or SCL (cm)	n/a	
Age at maturity (yrs)	n/a	
Clutch size (n eggs) (N)	n/a	
Emergence success (hatchlings/egg) (N)	n/a	
Nesting success (Nests/ Tot emergence tracks) (N)	n/a	
Trends		
Recent trends (last 20 yrs) at nesting sites (range of years)	n/a	
Recent trends (last 20 yrs) at foraging grounds (range of years)	n/a	
Oldest documented abundance: nests/yr (range of years)	n/a	
Published studies		
Growth rates	N	
Genetics	N	
Stocks defined by genetic markers	N	
Remote tracking (satellite or other)	N	
Survival rates	N	
Population dynamics	N	

Foraging ecology (diet or isotopes)	N	
Capture-Mark-Recapture	N	
Threats		
Bycatch: presence of small scale / artisanal fisheries?	Y (PLL, DLL, SN, DN, ST, MT, PT)	59
Bycatch: presence of industrial fisheries?	Y (PLL, SN, BT)	
Bycatch: quantified?	N	
Take. Intentional killing or exploitation of turtles	Y	
Take. Egg poaching	Y	
Coastal Development. Nesting habitat degradation	Y	
Coastal Development. Photopollution	Y	
Coastal Development. Boat strikes	Y	
Egg predation	Y	
Pollution (debris, chemical)	Y	
Pathogens	N	
Climate change	Y	
Foraging habitat degradation	N	
Other	Y (see text)	
Long-term projects		
Monitoring at nesting sites	Y	
Number of index nesting sites	10	
Monitoring at foraging sites	N	
Conservation		
Protection under national law	Y	
Number of protected nesting sites (habitat preservation)	11	
Number of Marine Areas with mitigation of threats	11	
Long-term conservation projects (number)	3	

In-situ nest protection (eg cages)	Y	
Hatcheries	Y	
Head-starting	N	
By-catch: fishing gear modifications (eg, TED, circle hooks)	BT,PLL	
By-catch: onboard best practices	N	
By-catch: spatio-temporal closures/reduction	N	
Other	Y (see text)	

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)	Southern Western limit		Northern Eastern limit		Central point		Length (km)	% Monitored	Reference #	Monitoring Level (1-2)	Monitoring Protocol (A-F)
				Lat	Long	Lat	Long	Lat	Long					
CM-EP IND														
La Playita	N	8.3 (2015-2017)	16.6 (2008-2016)	-1.567051	-80.83884	-1.562954	-80.835042			0.8	100	1,2,3	1	B
Salango	N	7 (2013; 2016)	6.5 (2008-2016)	-1.598321	-80.8510	-1.570236	-80.840971			3.6	100	1,2,3,4	1	B
Salaite	N	4 (2014)	4.7 (2008-2016)	-1.40632	-80.754453	-1.391433	-80.759474			1.77	100	5	1	B
Los Frailes	N	1 (2014)	9.5 (2008-2011, 2014)	-1.498012	-80.797867	-1.488703	-80.793389			1.5	100	5	1	B
San Lorenzo	N	5 (2013-2014; 2016-2017)	n/a					-1.068554	-80.907768	2.64	100	6,7,8	1	B
La Botada	N	3.25 (2013-2014; 2016-2017)	n/a					-1.050000	-80.904193	1.5	100	6,7,8	1	B
Santa Marianita	N	4 (2014)	n/a					-0.962986	-80.832935	3.3	n/a	8	n/a	n/a
Playa Rosada & Playa Chipi-chipi	N	6 (2016)	n/a	-2.009946	-80.749705	-2.003524	-80.750037			0.860	100	9	1	B

Playa Dorada	Y	12.67 (2014-2016)	14.3 (2014-2016)	-1.622874	-80.843368	-1.619742	-80.84355			0.320	60	43	n/a	n/a
Las Tunas	N	6.67 (2014-2016)	10 (2014-2016)	-1.683954	-80.811126	-1.630429	-80.837369			6.000	40	43	n/a	n/a
Quinta Playa, Galapagos	Y	2769 (2009-2013; 2015)	2336.75 (2009-2013)					-1.00616	-91.081	2	100	10, 11, 58	1	B
Bahía Barahoa, Galapagos	Y	1726.5 (2009-2011)	2877 (2009-2011)					-1.001694	-91.058849	1.2	100	58	1	B
Las Bachas, Galapagos	Y	613.7 (2010, 2013, 2015)	884 (2010, 2013)					-0.494063	-90.339391	n/a	100	10, 58	1	B
Tortuga Bay, Galapagos	Y	46 (2015)	n/a					-0.761473	-90.335652	1.1	n/a	11	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
San Jacinto	N	1 (2016)	n/a					-0.782666	-80.518363	6.7	0	12	n/a	n/a
Bahía Drake, Isla de La Plata	Y	48 (2011)	168 (2009-2011)	-1.270346	-81.063053	-1.267836	-81.066363			0.47	100	13	1	B
Mar Bravo	N	1 (2015)	n/a					-2.24544	-80.95087	13.2	n/a	14	1	B
Tres Cruces	N	6 (2015)	n/a					-2.19158	-81.00374	1.1	100	14	1	B
Punta Brava	N	3 (2014)	n/a					-2.1993	-80.99751	0.870	100	15	1	B
EI-EP IND														
La Playita	Y	29.7 (2015-2017)	-	-1.567051	-80.83884	-1.562954	-80.835042			0.800	100	1,2,3,35	1	B
Puerto López	N	3 (2017)	-	-1.562801	-80.818647	-1.530318	-80.812545			4	100	1	1	B
Salango	N	1 (2015-2017)	-	-1.598321	-80.8510	-1.570236	-80.840971			3.6	100	1,2,3	1	B

Los Frailes	N	1 (2017)	-	-1.498012	-80.797867	-1.488703	-80.793389			1.5	100	1	1	B
Playa Negra	N	7 (2015)	-	-1.482821	-80.792577	-1.481871	-80.792369			0.113	100	2	1	B
Tortuguita	N	2 (2008)	-	-1.486723	-80.793107	-1.484134	-80.792567			0.347	100	16	1	B
Salaite	N	1 (2013)	-	-1.40632	-80.754453	-1.391433	-80.759474			1.77	100	4	1	B
Playa Dorada	N	2.33 (2014-2016)	6 (2014-2016)	-1.622874	-80.843368	-1.619742	-80.84355			0.320	50	43	n/a	n/a
Las Tunas	N	0.67 (2014-2016)	2.33 (2014-2016)	-1.683954	-80.811126	-1.630429	-80.837369			6.000	40	43	n/a	n/a
Playa Rosada & Playa Chipi-chipi	Y	41 (2016-2017)	-	-2.009946	-80.749705	-2.003524	-80.750037			0.860	100	9, 17, 35, 44	1	B
Playa de Portete Chico	N	1.5 (2016-2017)	-					n/a	n/a	0.280	n/a	9, 17	n/a	n/a
Punta Carola, Galapagos	N	1 (2016-2017)	-					-0.89995	-89.60949	0.030	0	18, 19	n/a	n/a
Punta Brava	N	1 (2015)	-					-2.1993	-80.99751	0.870	100	14	1	B
Portete	N	1 (2015)	-	0.47039	-80.053468	0.487126	-80.046194			2.15	100	20	1	B
DC-EP IND														
Puerto López	N	1 (2014)	-	-1.562801	-80.818647	-1.530318	-80.812545			4	100	20		
San Lorenzo	N	1 (2013)	-					-1.068554	-80.907768	2.64	100	8		
Santa Marianita	N	1 (2014)	-					-0.962986	-80.832935	3.3	n/a	8	n/a	n/a
Puerto Cabuyal	N	1 (2015-2016)	-					-0.191272	-80.334106	4.6	n/a	12	n/a	n/a

Same	N	1 (2008)	-	0.826124	-79.952499	0.852943	-79.920023			4.7	n/a	21	n/a	n/a
LO-EP IND														
La Playita	N	1.5 (2015-2017)	-	-1.567051	-80.83884	-1.562954	-80.835042			0.8	100	1,2,3	1	B
Puerto López	N	5 (2017)	-	-1.562801	-80.818647	-1.530318	-80.812545			4	100	1	1	B
Playa Dorada	N	4 (2014-2016)	10.67 (2014-2016)	-1.622874	-80.843368	-1.619742	-80.84355			0.320	50	43	n/a	n/a
Las Tunas	Y	15.25 (2008, 2014-2016)	35 (2014-2016)	-1.683954	-80.811126	-1.630429	-80.837369			6.000	40	22, 43	n/a	n/a
San Lorenzo	Y	127.2 (2013-2014; 2016-2017)	-					-1.068554	-80.907768	2.64		6,7,8, 61	1	B
La Botada	Y	95.2 (2013-2014; 2016-2017)	-					-1.050000	-80.904193	1.5		6,7,8, 61	1	B
Santa Marianita	Y	15 (2014; 2016-2017)	-					-0.962986	-80.832935	3.3		6,7,8, 61	n/a	n/a
Ligüiqui	N	5 (2014; 2016-2017)	-					-1.027514	-80.88311	0.500		6,7,8, 61	1	B
Murciélago	N	2 (2015-2017)	-					-0.940283	-80.733805	2		7,8, 61	n/a	n/a
San José	N	7 (2017)	-					-1.23501	-80.82531	4.88	n/a	6	n/a	n/a
Rio Caña	N	1 (2016)	-					-1.085000	-80.900531	2	n/a	7	n/a	n/a
Crucita	Y	15 (2016-2017)	-					-0.87185	-80.54105	4.15	n/a	23, 24	n/a	n/a
Canoa	N	1 (2015)	-					-0.46764	-80.45612	7.09	n/a	25	n/a	n/a
Playa Rosada & Playa Chipi-chipi	N	1 (2017)	-	-2.009946	-80.749705	-2.003524	-80.750037			0.860	100	17	1	B

Playa Bruja	N	4.7 (2015-2017)	-					-2.18658	-80.84078	1	n/a	9,17,26	n/a	n/a
Playa de Valdivia	N	3.3 (2015-2017)	-					-1.94485	-80.72732	2	n/a	9,17,26	n/a	n/a
Playa de Palmar	N	1 (2017)	-					-2.02871	-80.73551	2.1	n/a	17	n/a	n/a
Montañita	N	2 (2017)	-					-1.82303	-80.75539	1	n/a	17	n/a	n/a
Olón	N	1 (2017)	-					-1.79652	-80.76036	7.15	n/a	17	n/a	n/a
Mar Bravo	Y	26.3 (2013-2014; 2017)	-					-2.24544	-80.95087	13.2	n/a	15,27	1	B
Punta Brava	N	7.6 (2013-2014; 2017)	-					-2.1993	-80.99751	0.870	100	15,27	1	B
Tres Cruces	N	8.3 (2013-2014; 2017)	-					-2.19158	-81.00374	1.1	100	15,27	1	B
Punta Carnero	N	2 (2013)	-					-2.27717	-80.92005	10	n/a	15	n/a	n/a
La Diablica	N	1 (2013)	-					-2.31763	-80.89557	3	n/a	15	n/a	n/a
Galera	N	2.5 (2016-2017)	-					0.81858	-80.04574	1.66	n/a	28,61	n/a	n/a
Galerita	Y	28.7 (2015-2017)	-					0.82032	-80.05385	0.635	n/a	26,28,61	n/a	n/a
Tongorachi	N	1 (2017)	-					n/a	n/a	n/a	n/a	28	n/a	n/a
Quingue	Y	13.5 (2015;2017)	-					0.71966	-80.0947	4	n/a	26,28	n/a	n/a
Tongora	N	2 (2017)	-					n/a	n/a	n/a	n/a	28	n/a	n/a
Piquero	N	2 (2015; 2017)	-					n/a	n/a	n/a	n/a	26,28	n/a	n/a
El Morro	N	1.5 (2015; 2017)	-					n/a	n/a	n/a	n/a	26,28	n/a	n/a
La Manga	N	1 (2015)	-					n/a	n/a	n/a	n/a	26	n/a	n/a

Estero de Platano	N	1 (2015)	-					0.77724	-80.0893	0.676	n/a	26	n/a	n/a
Caimito	N	2 (2015)	-					0.66523	-80.09393	0.29	n/a	26	n/a	n/a
Playa Escondida	N	1 (2015)	-					0.81779	-80.00601	0.25	n/a	26	n/a	n/a
Las Palmas	Y	88.5 (2016-2017)	-					0.99082	-79.66096	2.6	n/a	29,61	n/a	n/a
Portete	Y	77 (2012-2015)		0.47039	-80.053468	0.487126	-80.046194			2.15	100	20, 30, 31	1	B
Mompiche	N	2 (2009)	-					0.5063	-80.02424	1.24	0	32	n/a	n/a
Same	N	1 (2010)	-	0.826124	-79.952499	0.852943	-79.920023			4.7	n/a	33	n/a	n/a
Bahía Drake (Isla de La Plata)	N	1 (2008)	-	-1.270346	-81.063053	-1.267836	-81.066363			0.47	100	13	1	B

Table 3. International conventions protecting sea turtles and signed in Ecuador.

International Conventions	Signed	Binding	Compliance measured and reported	Species	Conservation actions	Relevance to sea turtles
IAC	Y	Y	Y	ALL		
CMS	Y	N	Y	ALL		
CITES	N	N	n/a	ALL		
IATTC	Y	N	n/a	ALL		
Lima Convention	Y	N	n/a	ALL		
The Eastern Tropical Pacific Marine Corridor	Y	N	n/a	ALL		
RAMSAR	Y	N	n/a	EI	Protection of important habitat such as mangrove estuaries	Isla Santay in Ecuador is an important estuary for sea turltes, hawksbill sea turtles have been observed migrating towards the mangroves in this area.
United Nations-Convention on Biological Diversity CBD	Y	Y	n/a	ALL		Protects fragiles ecosystems such as mangroves and marine ecosystems. Especial interst in Galapagos
Decisión 391 de la Comunidad Andina de Naciones sobre el Acceso a Recursos Genéticos	Y	Y	n/a			Protects access to genetic resources

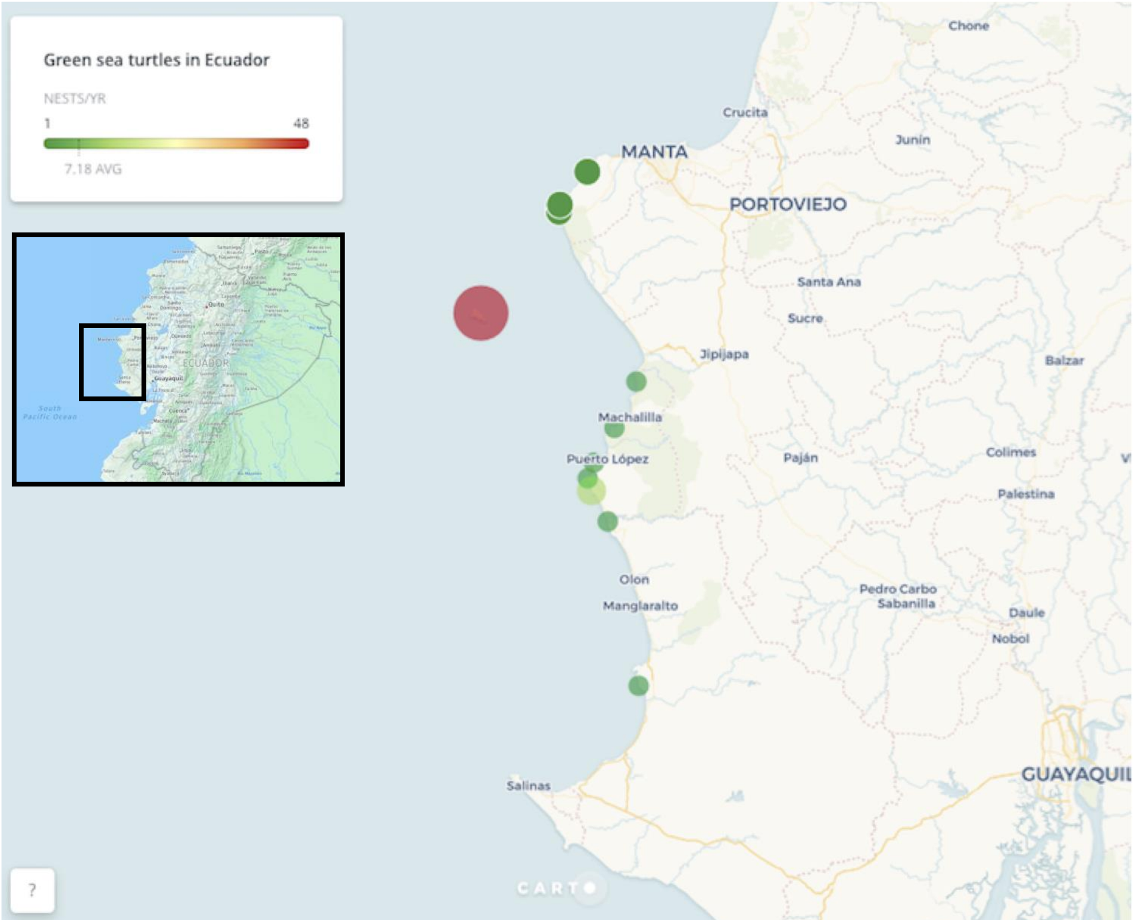


Figure 1. Green sea turtle nesting distribution and abundance in continental Ecuador. Bahía Drake (in red) is the most abundant nesting site.

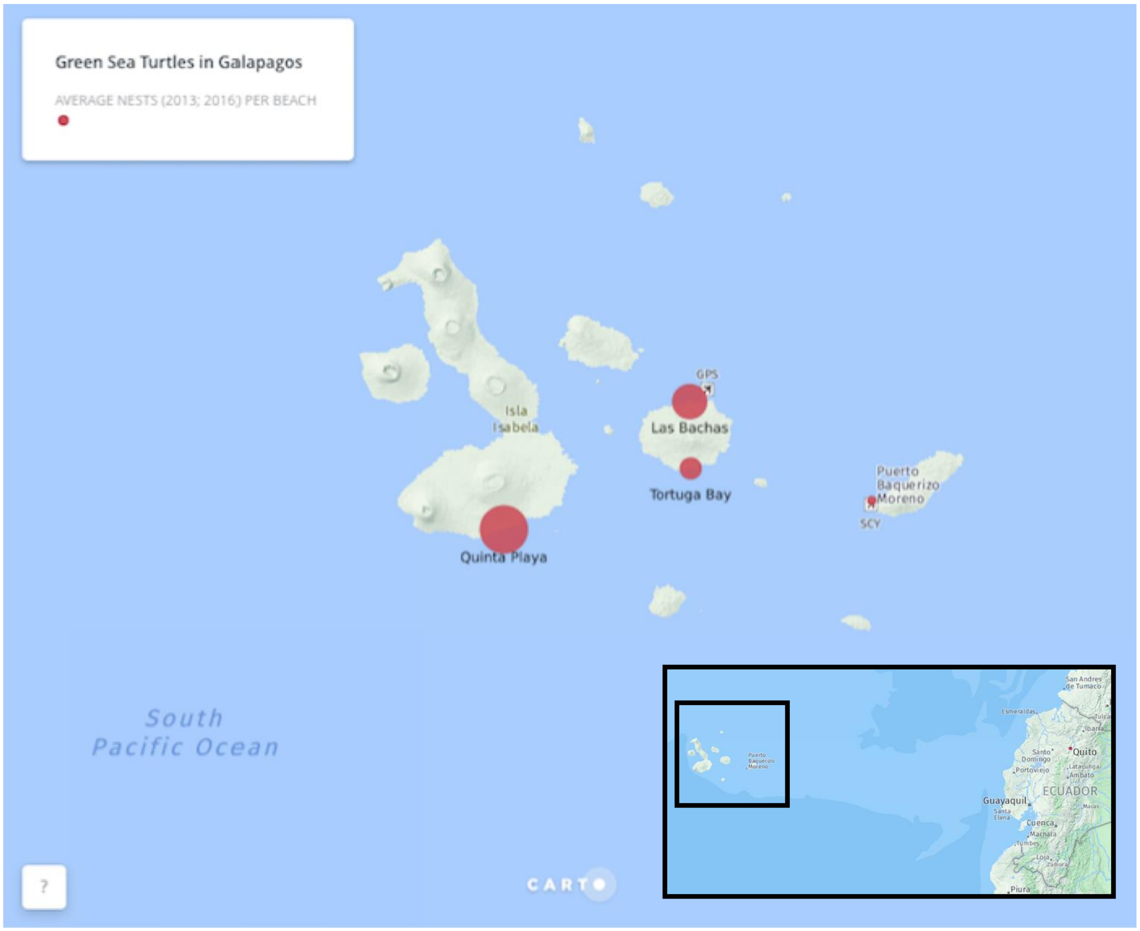


Figure 2. Green sea turtle nesting distribution in the Galapagos Islands. Abundance is shown, being Quinta Playa the beach with most nesting abundance. Barahona Bay, next to Quinta Playa is not shown on the map.

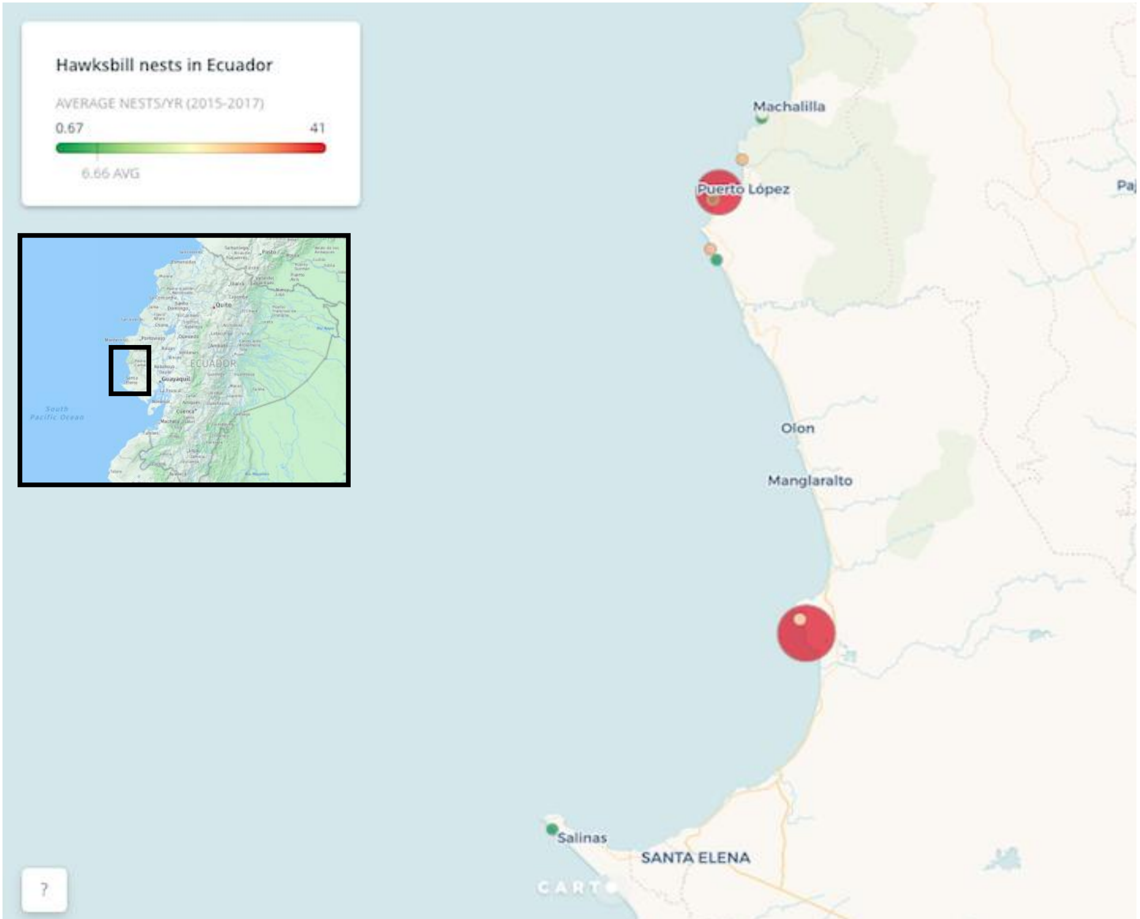


Figure 3. Nesting beaches for *Eretmochelys imbricata* in south-central Ecuador. The beaches with greater abundance (Playa Dorada and La Playita) are in red. Portete in Esmeraldas province and San Cristobal-Galapagos are not included in the figure as only 1 nest has been registered in each site.

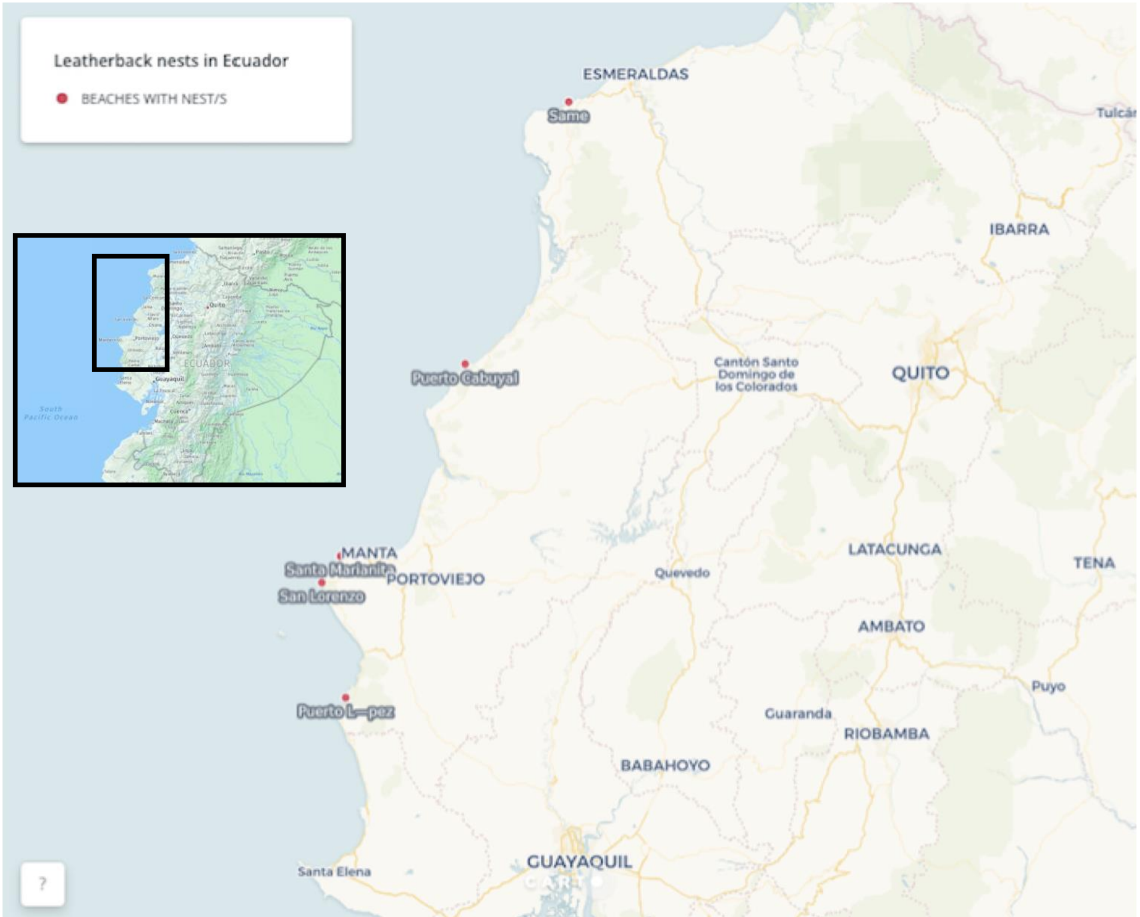


Figure 4. Beaches (5) in Ecuador where *Dermochelys coriacea* nests have been reported.

Figure 5. Leatherback turtle stranded in Mompiche, Esmeraldas province, with injuries on the anterior flippers, possibly from gillnets.

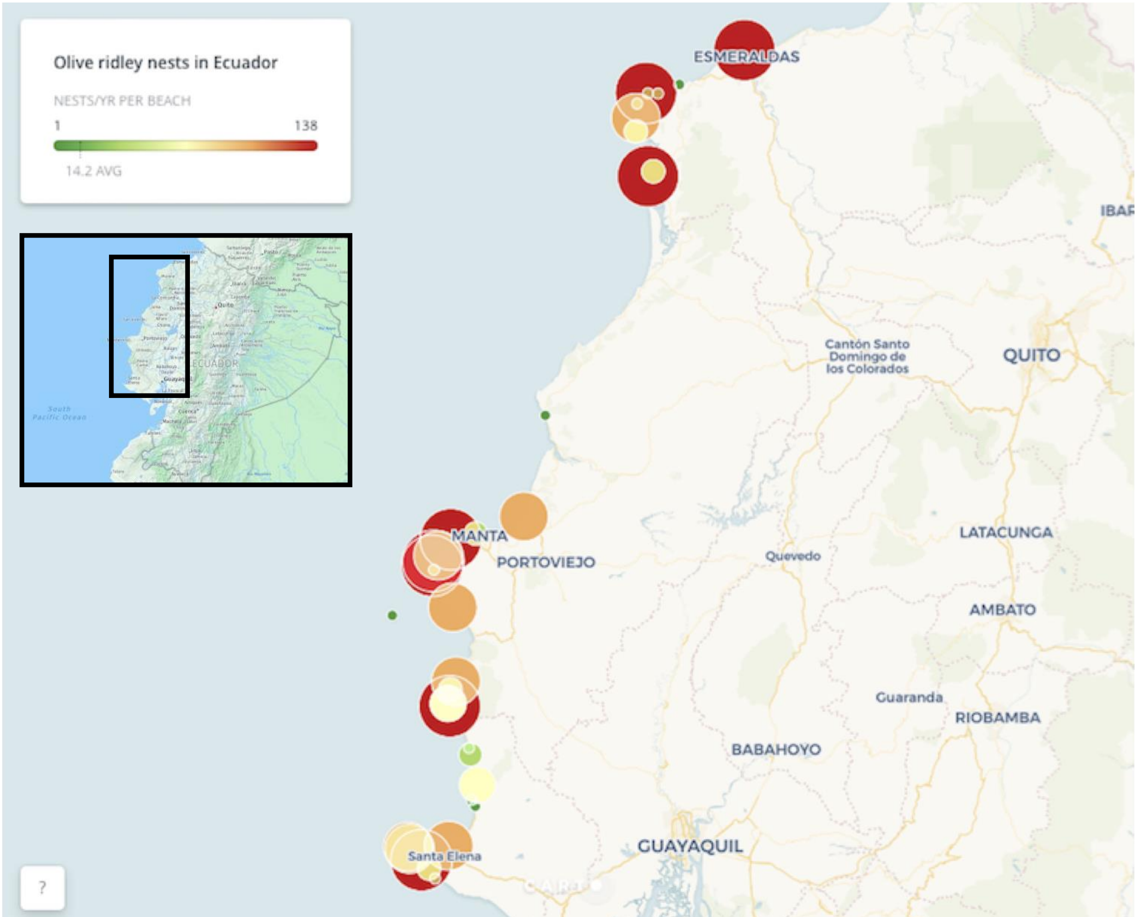


Figure 6. Nesting beaches for *Lepidochelys olivacea* in continental Ecuador. The beaches with greater abundance (San Lorenzo, La Botada, Las Palmas and Portete) are in red.

REFERENCES

1. Miranda, C. 2017. Evaluación de las áreas críticas de anidación y alimentación para tortugas marinas en la zona marina del Parque Nacional Machalilla y su área de influencia del cantón Puerto López en la provincia de Manabí. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2017.

2. Miranda, C. 2016. Evaluación de las áreas críticas de anidación y alimentación para tortugas marinas en la zona marina del Parque Nacional Machalilla y su área de influencia del cantón Puerto López en la provincia de Manabí. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2016.

3. Espinoza, H. E. 2015. Parque Nacional Machalilla Temporada de anidación 2014-2015. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2016.

4. Lemarie, C., et, al. 2014. Evaluación de las áreas críticas de anidación y alimentación para tortugas marinas en la zona marina del Parque Nacional Machalilla y su área de influencia del CantónPuerto López de la Provincia de Manabí. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2014.

5. Miranda, C. 2015. Equilibrio Azul Sea Turtle Monitoring Project, Ecuador: Unpublished Data. SWOT, Vol 11.

6. Solorzano, I. 2017. Conservación de tortugas marinas; reducción de las amenazas al hábitat de anidación dentro del Refugio de Vida Silvestre y Marino Costera Pacoche y su zona de influencia 2016. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2017.

7. Solorzano, I. 2016. Conservación de tortugas marinas; reducción de las amenazas al hábitat de anidación dentro del Refugio de Vida Silvestre y Marino Costera Pacoche y su zona de influencia (4ta temporada). Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2016.

8. Ponce, L. 2014. Resultados del segundo periodo anual de monitoreo de tortugas marinas en el Refugio de Vida Silvestre y Marino Costera Pacochey y su zona de influencia Manta-Manabí-Ecuador Junio de 2013-marzo 2014. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2014.

9. Carillo, B. 2016. Monitoreo de sitios de anidación en las playas de la Reserva Marina El Pelado. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2016.

10. Espinoza, E., et al. 2014. Monitoreo de la anidación de tortuga verde Chelonia mydas en Galápagos, temporada 2012 – 2013 y 2013 – 2014. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2014.

11. Espinoza, E., & Proaño, A. 2016. Monitoreo de la anidación de tortugas marinas en la Reserva Marina de Galápagos. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2016.

12. Cruz, C. & Córdova, T. 2016. Reporte Anual de Monitoreo y Atención de Fauna Marina (Tortugas) desde el Refugio de Vida Silvestre Islas Corazón y Fragatas. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2016.

13. SWOT, Vol 11. Data Record 26.

14. Ladines, B. 2015. Conservación de sitios de anidación de tortugas marinas mediante la reducción de amenazas dentro de la Reserva de Producción de Fauna Marina Costera Puntilla de Santa Elena, Playas de Santa Elena, Playas Tres Cruces, Punta Brava y Mar Bravo. Temporada 2014-2015. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2015.

15. Ladines, B. 2014. Monitoreo y protección de nidos de tortugas marinas en la Reserva de Producción de Fauna Marina Costera Puntilla de Santa Elena (REMACOPSE), durante el período 2013 – 2014.Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2014.

16. SWOT, Vol 11. Data Record 27.

17. Pilay, A. 2017. Monitoreo de sitios de anidación e tortugas marinas en las playas de la reserva marina "El Pelado". Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2017.

18. Espinoza, E. 2016. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2016.

19. Espinoza, E. 2017. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2017.

20. SWOT, Vol 11. Data Record 25.

21. Miranda, C. Anecdotical data.

22. Equilibrio Azul. 2009. Sea turtle nesting in Las Tunas, Ecuador: Personal communication. In SWOT Report-State of the World's Sea Turtles, vol. V (2010).

23. Moreira, J. 2016. Seguimiento a la anidación de tortugas marinas en el balneario de Crucita, impactos y problemas encontrados en el sitio. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2016.

24. Moreira, J. 2017. Seguimiento a la anidación de tortugas marinas en el balneario de Crucita, impactos y problemas encontrados en el sitio. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2016.

25. Vera, M. 2015.Reporte anual de monitoreo y atención de fauna marina (Tortugas) desde el Refugio de Vida Silvestre Islas Corazón y Fragatas. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2015.

26. Espinoza, E. 2015. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2015.

27. Ladines, B. 2017. Conservación de sitios de anidación de tortugas marinas mediante la reducción de amenazas dentro de la Reserva de Producción de Fauna Marina Costera Puntilla de Santa Elena, Playas Tres Cruces, Punta Brava y Mar Bravo. Salinas Ecuador. Temporada 2016 - 2017. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2017.

28. Sosa, A. 2017. Protección de nidos de Tortugas marinas en la Reserva Marina Galera San Francisco. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2017.

29. Tene, R. 2017. Monitoreo de Tortugas Marinas - Temporada de anidación 2016. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2017.

30. Miranda, C. 2012. Proyecto de conservación de tortugas marinas en Portete, Ecuador. Informe Final de Proyecto.
31. Miranda, C. 2013. Informe de monitoreo de anidación en la playa de Portete. Proyecto de Turismo Comunitario, Conservación de Ecosistemas Costeros, en la Parroquia de Bolívar, Esmeraldas. Informe Equilibrio Azul.

32. Baquero, A., Muñoz, J.P., Peña, M., & Equilibrio Azul. 2010. Olive ridley nesting in Mompiche and Montañita, Ecuador: Personal communication. In SWOT Report-State of the World's Sea Turtles, vol. V (2010).

33. Herrera, M., Coello, D., Flores, C. 2009. Notas preliminares: Cabo San Lorenzo, su importancia como área de reproducción de tortugas marinas en el Ecuador. In SWOT Report-State of the World's Sea Turtles, vol. XI (2015-2016).

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

35. Gaos, A. R., et al. 2017. Living on the Edge: Hawksbill turtle nesting and conservation along the Eastern Pacific Rim. Latin american journal of aquatic research 45.3 (2017): 572-584.

36. Gaos, A. R., Lewison, R. L., Jensen, M. P, Liles, M. J., et al. 2017. Natal foraging philopatry in eastern Pacific hawksbill turtles. R. Soc. open sci. DOI: 10.1098/rsos.170153.

37. Gaos, A. R., Lewison, R. L., Yañez, I. L. Wallace, B. P., Liles, M. J., Nichols, W. L., Baquero, A., Hasbún, C. R., Vasquez, M., Urteaga, J., Seminoff, J. A. 2012. Shifting the life history paradigm: discovery of novel habitat use by hawksbill turtles. Biol. Lett. 8: 54-56.

38. Miranda, C. 2016. Abundancia, distribución y migración de tortugas carey (Eretmochelys imbricata) en el agua, dentro y fuera del Parque Nacional Machalilla. Informe técnico como parte del estudio "Evaluación de las áreas críticas de anidación y alimentación para tortugas marinas en la zona marina del Parque Nacional Machalilla y su área de influencia del cantón Puerto López en la provincia de Manabi. Equilibrio Azul, permiso de investigación No. 022AT-DPAM-MAE.

39. Alarcón-Ruales, D., Muñoz-Pérez, J. P., Hirschfeld, M., Gaos, A., Denkinger, J., Vaca-Pita, L., Chaves, J. A., Valdes, J., Castañeda, J. G., García, J., Quintero, C., Lewbart, G. A., Lohmann, K. J. 2016. Hawksbill turtles (Eretmochelys imbricata) in the Galapagos. 36th Annual Symposium on Sea Turtle Biology and Conservation.

40. Chaves, J. A., Peña, M., Valdés-Uribe, J. A., Muñoz-Pérez, J. P., Vallejo, F., Heidemeyer, M., Torres-Carvajal, O. 2017. Connectivity, population structure, and conservation of Ecuadorian green sea turtles. Endang Species Res. 32: 251-264.

41. Seminoff, J. A., Zárate, P., Coyne, M., Foley, D. G., Parker, D., Lyon, B. N., Dutton, P. H. 2008. Post-nesting migrations of Galápagos green turtles Chelonia mydas in relation to oceanographic conditions: integrating satellite telemetry with remotely sensed ocean data. Endang Species Res. 4: 57–72.

42. Alemán, R. 2016. Identificación del primer caso de papiloma en tortugas marinas en el Ecuador continental. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2016.

43. Delgado, B. 2017. Beach monitoring of Jocotoco Foundation at Las Tunas and Playa Dorada. Personal Communication.

44. Darquea J., Medina, R., López, A. 2016. Estimación de la población anidante y ruta migratoria de tortuga Carey (Eretmochelys imbricata) en Playa Rosada, Reserva Marina El Pelado. Ecuador Mundo Ecológico. Permiso de Investigación No. 016-IC-FA- DPSE-MA-2015. Personal Communication.

45. Zarate, P., Fernie, A., Dutton, P. H. 2003. First results of the East Pacific green turtle, Chelonia mydas, nesting population assessment in the Galapagos Islands. Conference Paper: Twenty-second Annual Symposium on Sea Turtle Biology and Conservation, At Miami, FL, Volume: NOAA Technical Memorandum NMFS-SEFSC-503.

46. Seminoff 2004. Red List assessment of the Green Turtle (Cheloniamydas) by Jeffrey Seminoff and the MTSG Green Turtle Task Force.UICN–SSC Red List Authority, USA.

47. Hurtado, M. (1984). "Registro de anidación de la tortuga negra, Chelonia mydas, en las Islas Galápagos". Boletín científico y Técnico. Instituto Nacional de Pesca, Ecuador 6(3): pp77-104.

48. Seminoff, J.A. Zárate, P., Coyne, M., Foley, D. G., Parker, D., Lyon, B. N., Dutton, P. H. 2008. Post-nesting migrations of Galápagos green turtles Chelonia mydas in relation to oceanographic conditions: integrating satellite telemetry with remotely sensed ocean data. Endang Species Res. 4: 57–72.

49. Sugierski, S. A. The Threat of Sea Level Rise on The Nesting Area of Punta Carola Beach in San Cristóbal, Galápagos Islands. ENEC 395 Independent Research Project, Spring 2016. Personal Communication.

50. Miranda, C., Vallejo, F., Rodriguez, P., Lemarie, C., Espinoza, E., Baquero, A. 2015. Five years monitoring the nesting and in-water population of black sea turtles (Chelonia mydas) at La Plata Island, Machalilla National Park with the first evidence of connectivity with the Galapagos Islands.

51. Aleman, R. 2017. Rehabilitación de fauna marina. Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2017.

52. Alarcón-Ruales, D. 2015. Marine turtles and Boats in the Galápagos: recommendations for a boat traffic management plan at San Cristóbal Island. Independent Project EV5914-EV5915. James Cook University Master of Science.

53. Parra, M., Jiménez, J., Toral, V. 2014. Evaluación de la incidencia de impacto de embarcaciones en tortuga verde (Chelonia mydas)en el sur de Isabela, Galápagos. In: DPNG, CGREG, FCD y GC. 2015. Informe Galápagos 2013-2014. Puerto Ayora, Galápagos, Ecuador.

54. Hurtado, M. (1987). Las tortugas marinas y la pesca artesanal. Subsecretaría de Recursos Pesqueros INP/ EPM. Revista la Pesca Artesanal en Ecuador: 34-37.

55. Gaos, A., Abreu-Grobois, F., Alfaro-Shigueto, J., Amorocho, D., Arauz, R., Baquero, A., . . . Zárate, P. (2010). Signs of hope in the eastern Pacific: International collaboration reveals encouraging status for a severely depleted population of hawksbill turtles Eretmochelys imbricata. Oryx, 44(4), 595-601.

56. Seminoff J. A., Wallace, B. P. 2012. Sea Turtles of the Eastern Pacific: Advances in Research and Conservation. University of Arizona Press, Tucson. 386 pp.

57. Álvarez-Varas, R., Contardo, J., Heidemeyer, M., Forero-Rozo, L., Brito, B., Cortés, V., Brain, M. J., Pereira, S., & Vianna, J. A. 2017. Ecology, health and genetic characterization of the southernmost green turtle (Chelonia mydas) aggregation in the Eastern Pacific: implications for local conservation strategies. Latin american journal of aquatic research, 45(3), 540-554. https://dx.doi.org/10.3856/vol45-issue3-fulltext-4

58. Parra, M. 2016. Informe Final de monitoreo de anidación de la tortuga verde, Chelonia mydas, en las Islas Galápagos, temporadas 2009 a 2013 Reporte Técnico. Fundación Charles Darwin. Puerto Ayora, Galápagos, Ecuador, 52pp.

59. Equilibrio Azul. 2010. Proyecto Equilibrio Azul-ABC-Monitoreo del bycath en Palangre, Costa Centro, Sur de Ecuador. Unpublished data.
60. Vallejo, A., Campos, F. Anidación de Tortugas Marinas y Éxito de los Nidos en las Playas del Parque Nacional Machalilla y Zonas Aledañas Desde Agosto de 1996 hasta Julio de 1997. CDC Centro de Datos para la Conservación.

61. Subsecretaría de Gestión Marino-Costera (MAE). 2017. Informe preliminar de varamientos de especies marinas 2012-2017 y temporada 2017 de anidación de tortugas marinas.

62. Ministerio del Ambiente del Ecuador. 2014. Plan Nacional para la Conservación de las Tortugas Marinas. Guayaquil, Ecuador.

63. Roden, S. E., Morin, P., Frey, A., Balazs, G., Zarate, P., Cheng, I-J., Dutton, P. H. (2013). Green turtle population structure in the Pacific: new insights from SNPs and microsatellites. Endangered Species Research. 20. 227-234.

64. Zarate, P., Bjorndal, K. A., Seminoff, J., Bolten, A. B. 2012. Understanding migratory and foraging behavior of green turtles Chelonia mydas in the Galapagos Islands through stable isotopes. Conference: Thirty-first Annual Symposium on Sea Turtle Biology and Conservation., At San Diego, California, Volume: NOAA Technical Memorandum NOAA NMFS-SEFSC-631.

65. Carrion-Cortez, J. A., Zarate, P., Seminoff, J., 2010. Feeding ecology of the green sea turtle (Chelonia mydas) in the Galapagos Islands. Journal of the Marine Biological Association of the United Kingdom. 90. 1005 - 1013.

66. Green D. and Ortiz-Crespo F. (1982) Status of sea turtle populations inthe Central Eastern Pacific. In Bjorndal K. (ed.) Biology and conserva-tion of sea turtles. Washington, DC: Smithsonian Institution Press, pp.221– 233.

67. Green D. (1994) Galapagos sea turtles: an overview. In Schroeder B. andWitherington B. (eds) Proceedings of the 13th symposium on sea turtlebiology and conservation. NOAA Technical Memorandum NMFS–SEFSC, Florida, USA, pp. 65–68.

68. Zarate, P., Herrera, H., Contato, M. C. D., Bravo, I. E., Dutton, P. H., Seminoff, J. 2006. First record of fly larva depredation on green turtle developing eggs and hatchlings in the Galapagos Islands. Conference: 26th Annual Symposium on Sea Turtle Biology and Conservation, At Island of Crete, Greece.

69. Zarate, P. 2015. Somatic Growth Rates of Green Turtles (Chelonia mydas) and Hawksbills (Eretmochelys imbricata) in the Galápagos Islands. Journal of Herpetology. 49 (4): 641–648.

70. Dutton, P. H., Jensen, M., Frey, A., LaCasella, E., Balazs, G., Zarate, P., Chassin-Noria, O., Sarti-Martinez, L. A., Velez, E. 2014. Population structure and phylogeography reveal pathways of colonization by a migratory marine reptile (Chelonia mydas) in the central and eastern Pacific. Ecology and Evolution. 4.

71. Zarate, P., Bjorndal, K. A., Parra, M., Dutton, P. H., Seminoff, J., Bolten, A. B. 2013. Hatching and emergence success of green turtle (Chelonia mydas) in the Galápagos Islands. Aquatic Biology. 19. 217-229.

72. Gaos, A. R., Lewison, R. L., Liles, M. J., Gadea, V., Altamirano, E., Henríquez, A. V., … Dutton, P. H. (2016). Hawksbill turtle terra incognita: conservation genetics of eastern Pacific rookeries. Ecology and Evolution, 6(4), 1251–1264.

73. Gaos, A. R., Lewison, R. L., Wallace, B. P., Yañez, I. L., Liles, M. J., Nichols, W. J., Baquero, A., Habún, C. R., Vasquez, M., Urteaga, J., Seminoff, J. A. 2012. Spatial ecology of critically endangered hawksbill turtles Eretmochelys imbricata: implications for management and conservation. Vol. 450: 181–194.

74. Gaos, A. R., Lewison, R. R., Wallace, B. P., Yañez, I. L., Liles, M. J., Baquero, A., Seminoff, J. A. 2012. Dive behaviour of adult hawksbills (Eretmochelys imbricata, Linnaeus 1766) in the eastern Pacific Ocean highlights shallow depth use by the species. Journal of Experimental Marine Biology and Ecology. Vol. 432–433: 171-178.

75. Green D, Ortiz-Crespo F (1982) Status of sea turtle popula-tions in the central eastern Pacific. In: Bjorndal KA (ed)Biology and conservation of sea turtles. SmithsonianInstitution Press, Washington, DC, p 221−233.

76. Velez-Zuazo, X. & S. Kelez. 2010. Multiyear analysis of sea turtle bycatch by Peruvian longline fisheries: a genetic perspective. In: J.A. Blumenthal, A. Panago-poulou & A.F. Rees (eds.). Proceedings of the 30th Annual Symposiumon Sea Turtle Biology and Conservation, 24-30 April 2010, Goa, India.

77. Alfaro-Shigueto, J., J.C. Mangel, F. Bernedo, P.H. Dutton, J.A. Seminoff & B.J. Godley. 2011. Small-scale fisheries of Peru: a major sink for marine turtles in the Pacific. J. Appl. Ecol., 48(6): 1432-1440.

78. Amorocho, D.F., F.A. Abreu-Grobois, P.H. Dutton & R.D. Reina. 2012. Multiple distant origins for green sea turtles aggregating off Gorgona Island in the Colombian Eastern Pacific. PLoS ONE, 7(2).

79. Veliz, D., P. Salinas, W. Sielfeld, D. Contreras, C. Azócar, M. Tobar & J. Gallardo. 2014. Estudio poblacional y genético de la tortuga Chelonia mydas agassizii (Sauria: Cheloniidae) en La Playa Chinchorro, Arica, Chile. Rev. Biol. Mar. Oceanogr., 49(3): 589-593.

80. Donoso, M., P.H. Dutton & E. LaCasella. 2016. Nesting population origin of a Green turtle foraging aggregation in northern Chile determined from mtDNA analysis: drawing new boundaries to management units in the southeastern Pacific. 36th Annual Symposium on Sea Turtle Biology and Conservation, 29 February-4th March 2016, Lima, Peru.

81. Dutton P.H., E. LaCasella, Alfaro-Shiguetto, J. Paz-Campos, M. Donoso & J.C. Mangel. 2016. Stock origin of leatherback, loggerhead and green turtles foraging in the southeastern Pacific: insights into their trans-oceanic connectivity. 36th Annual Symposium on Sea Turtle Biology and Conservation, 29 February-4th March 2016, Lima, Peru.

82. Equilibrio Azul, ICAPO, The Lost Years Fund, NOAA. Neonate tracking of hawksbill seaturltes: accoustic and satelite telemetry on neonate and 1-year old hawksbill sea turtles. Unpublished data.

83. Alava, J. J., P. Jimenez, M. Peñafiel, W. Aguirre, and P. Amador. 2005. Sea turtle strandings and mortality in Ecuador: 1994-1999. Marine Turtle Newsletter 108:4- 7.

84. Alemán. R. 2017. Machalilla National Park Marine Fauna Rescue Center. Personal Communication.

85. Shillinger GL, Palacios DM, Bailey H, Bograd SJ, Swithenbank AM, et al. (2008) Persistent Leatherback Turtle Migrations Present Opportunities for Conservation. PLOS Biology 6(7): e171.

86. Regional Action Plan for reversing the decline of the east Pacific leatherback. NFWF & IUCN SSC Marine Turtle Specialist Group. https://savepacificleatherbacks.org/wp-content/uploads/2017/08/EP-Leatherback-Action-EN.pdf

87. NFWF. 2013. Reversing the Decline of the East Pacific Leatherback: A 10-year plan to stabilize the East Pacific Leatherback Regional Management Unit and reverse the current population trend to a recovery trajectory. http://www.nfwf.org/seaturtles/Documents/NFWF_business_plan_EP-leatherbacks_final.pdf

CHAPTER 9 PERU

Updated 2020

Evelyn Luna-Victoria[1], Shaleyla Kelez[2], Nelly De Paz[1,7], Carmen Rosa Gonzalez[2], Javier Quiñones[3], Angela Hernando[1], Juan Carlos Jerí[1,], Carlos Calagua[1], Joanna Alfaro-Shigueto[4], Ximena Velez-Zuazo[5], Kerstin Forsberg[6], David Sarmiento[8], David Torres[8], Vanessa Bachmann[9], Carlos Calvo[10], Manuel Vera[11], Andrea Pásara[4]

[1] WWF – Perú
[2] ecOceanica
[3] IMARPE - Pisco
[4] Pro Delphinus
[5] Smithsonian Conservation Biology Institute | National Zoological Park
[6] Planeta Océano
[7] ACOREMA
[8] IMARPE - Santa Rosa
[9] IMARPE (Central)
[10] ConservAcción
[11] IMARPE - Tumbes

1. RMU: *Eretmochelys imbricata* – Eastern Pacific Ocean (EI-EPO)

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. 2). 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 3). 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.

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 4).

2. RMU *Lepidochelys olivacea*, Eastern Pacific Ocean (LO-EPO)

2.1 Distribution, abundance, trends

2.1.1. Nesting sites

There are 18 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). 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. 2 and 3 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 3). 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 4). In the past, research was conducted on longline gear modification (circle hooks) but that is no longer in progress.

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: *Chelonia mydas*, East Pacific Ocean (CM-EPO)

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. 4). 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 5) Paracas bay which is one of the most important feeding areas in the South East Pacific, specially in La Aguada inlet (13°51'S; 76°15'W) (Ref 35,38,65,80,84) (See Fig 5, 6).

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 Virrila 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 publisehd 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 and (4) reducing the impacts that are generated by coastal activities.

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 *Dermochelys coriacea*, East Pacific Ocean (DC-EPO)

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. 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 drifnets 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.

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 *Caretta caretta*, South 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 2, 3 and 7 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).

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).

Table 1. Main biology and conservation aspects of sea turtles in Perú.

RMU	Ei	Ref #	Lo	Ref #	Dc	Ref #	Cc	Ref #	Cm	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	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	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
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	N		Y	35, 40, 84
Foraging ecology (diet or isotopes)	N		Y	65, 72, 91	Y	79	Y	4, 72	Y	13, 35, 39, 45, 57, 63, 65, 72, 80, 89, 103, 104, 105, 107
Capture-Mark-Recapture	N		N		N		N		Y	34, 39, 40, 80, 84, 105
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	Y(PLL, SN, DN)	5, 6,12, 21, 22, 31, 38, 42, 46, 48, 55, 65, 66, 69, 79, 81, 87, 93, 95, 106	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

Bycatch: presence of industrial fisheries?	N		N		Y	42	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	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	Y	5, 22, 31, 38, 42, 65, 79, 85, 93	Y	5	Y	5, 11, 18, 31, 34, 37, 38, 60, 65, 73, 82, 83, 85, 95, 103, 109
Take. Egg poaching	N		Y	49, 58	N		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	N		N		Y	31, 34, 38, 65, 73
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	Y	27, 31, 42, 54, 85	N		Y	27, 31, 34, 38, 44, 54, 62, 73, 85, 109
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, 101	Y	8,10,64, 101	Y	8, 10, 64, 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)	5	Pro Delphinus, ecOceanica, IMARPE, SERFOR, SERNANP	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, LEDs)	6, 9, 66	Y(circle hooks, LEDs)	6, 66, 102, 108	Y(circle hooks)	6, 66	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	Y	6, 7, 12, 66	Y	6, 7, 12, 55, 66, 106	Y	6, 7, 12, 55, 66	Y	6, 7, 12, 55, 56, 66
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: nesting, strandings, bycatch, ilegal trade	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 Perú.

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. Organizations, agencies and databases related with sea turtle research and conservation in Peru.

Institutions and organizations involved in conservation, management and research		
Public	SERFOR	The National Forest and Wildlife Service (SERFOR) from the Agriculture Ministry is the governmental body in charge of formulate environmental policies, currently developing the National Conservation Plan of Marine Turtles in Peru.
	SERNANP	The National Service of Protected Natural Areas (SERNANP) ascribed to the Environment Ministry manages natural protected areas and maintenance of biological diversity.
	IMARPE	The Peruvian Marine Research Institute (IMARPE) provides information to the Production Ministry and the scientific community about the marine ecosystem.
Private	WWF-Peru	The Marine Program of WWF-Peru is currently forging aliances to reduce bycatch, encouraging onboard best practices on correct handling and liberation of marine turtles focusing on the principal fisheries of the country and environmental education.
	Pro Delphinus	Pro Delphinus works assessing threats, testing bycatch solutions, and educating local communities about the importance of sea turtles in Perú.
	ACOREMA	Coastal Areas and Marine Resources (ACOREMA) works in coordination and collaboration with artisanal fishermen on sea turtle monitoring and bycatch reduction.
	ecOceánica	Evaluates nesting seasons, hatching and emergence success of green turtle and olive ridley in peruvian northern beaches, and the population structure and status of green turtle agregation in El Ñuro and Los Organos.
	Planeta Océano	Works in conservation and restore of coastal and marine environments.

Figure 1. Olive ridley nesting sites (Kelez, S., 2019 pers. comm., map elaborated by Carmen Rosa Gonzalez, 2019).

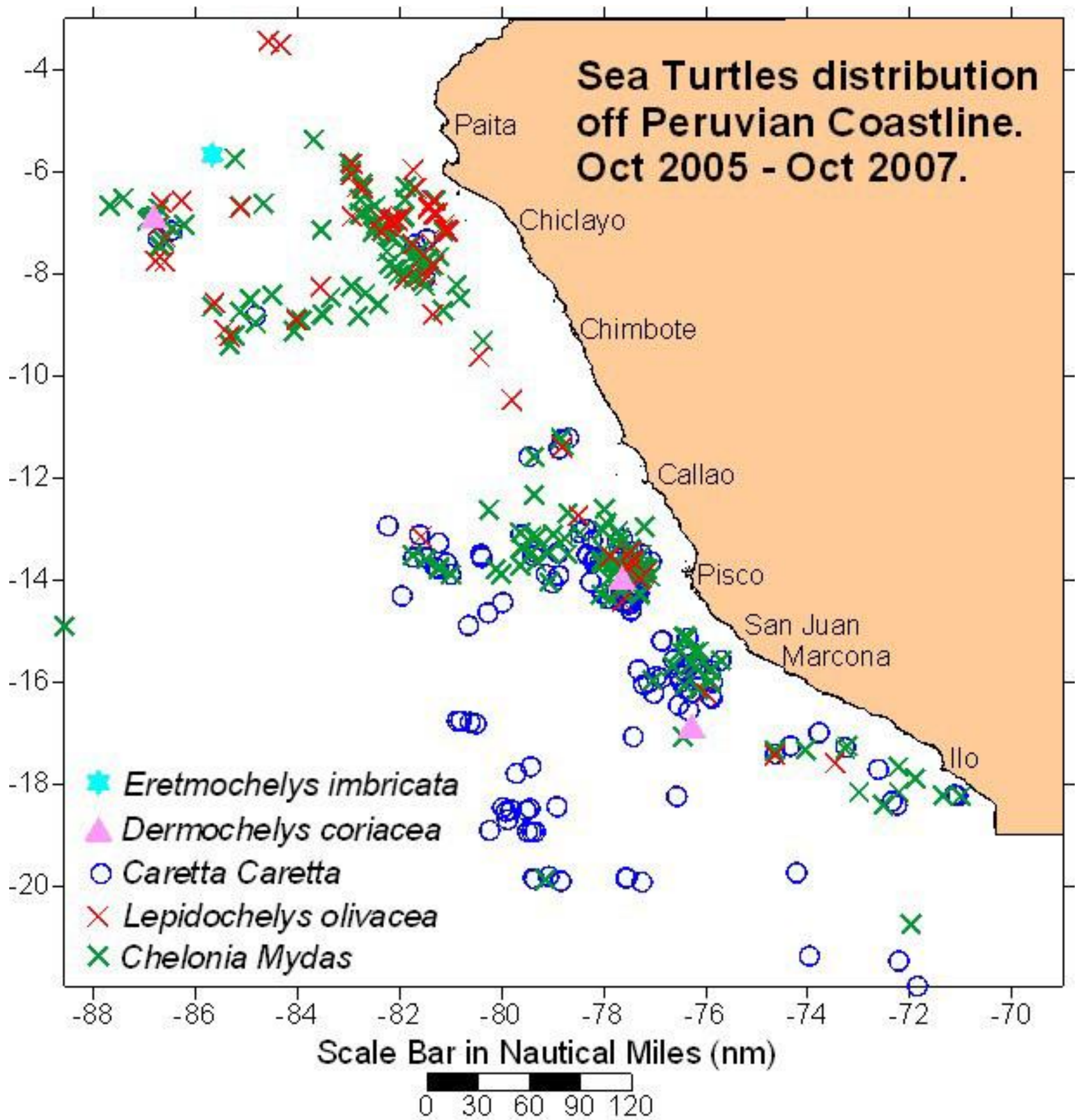


Figure 2. Sea turtle bycatch in pelagic longline off Peru. January 2005 - August 2007 (de Paz, et al. 2010, Ref 66).

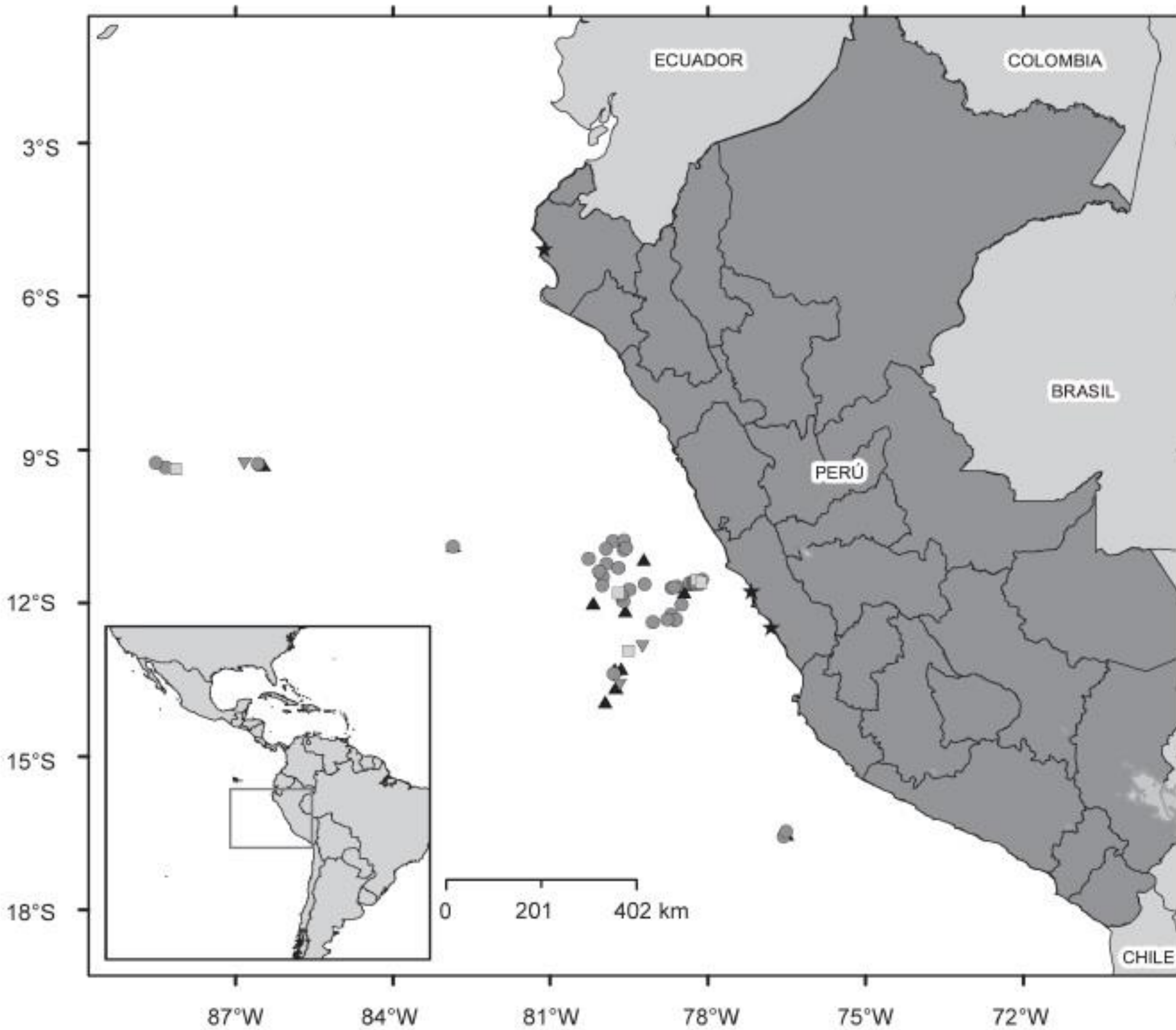


Figure 3. Sea turtle bycatch in pelagic longline off Peru. *Caretta caretta* (black triangles), *Chelonia mydas* (circles), *Lepidochelys olivacea* (squares), *Dermochelys coriacea* (inverted triangles). Sept 2009 - August 2010 (Ayala & Sanchez-Scaglioni 2010, Ref 69).

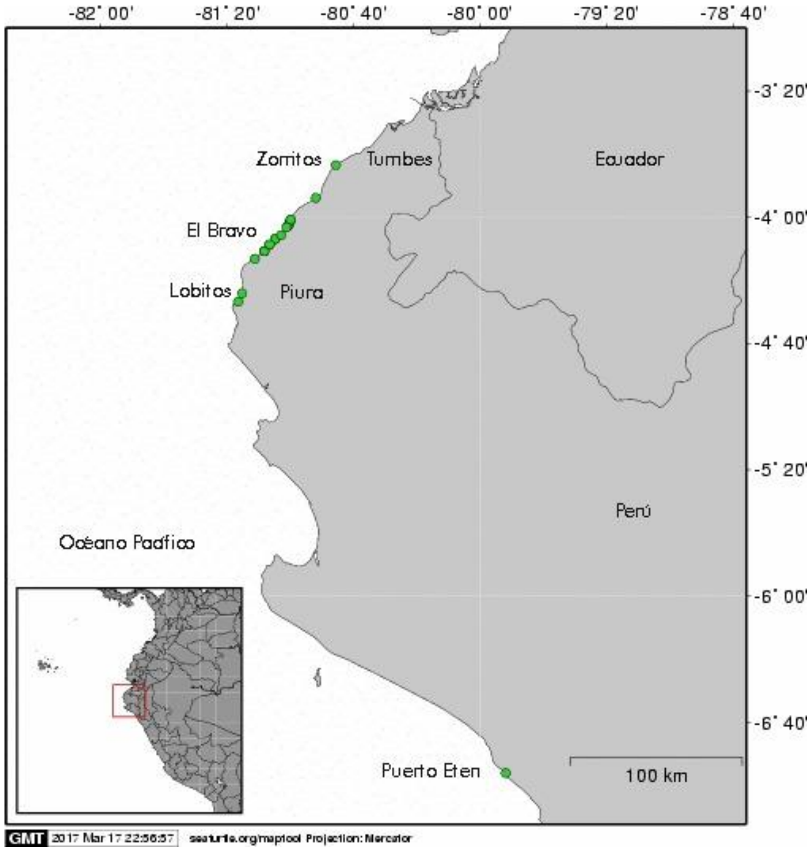


Figure 4. Places with confirmed nesting events of Chelonia mydas in northern beaches in Perú (ecOceánica, unpublished data).

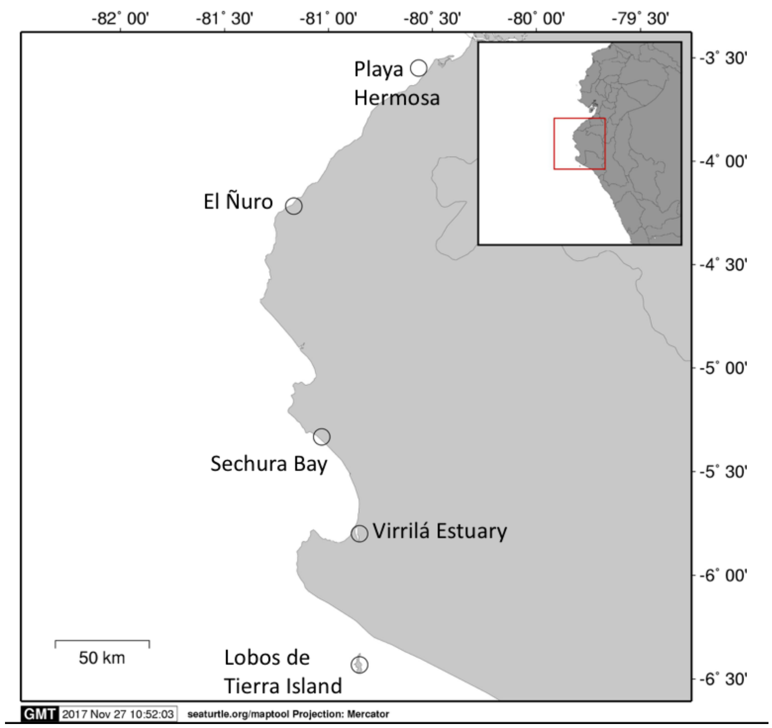


Figure 5. Principal foraging areas for Chelonia mydas identified in northern Perú (Ref 34, 37, 40, 57, N. de Paz pers. comm).

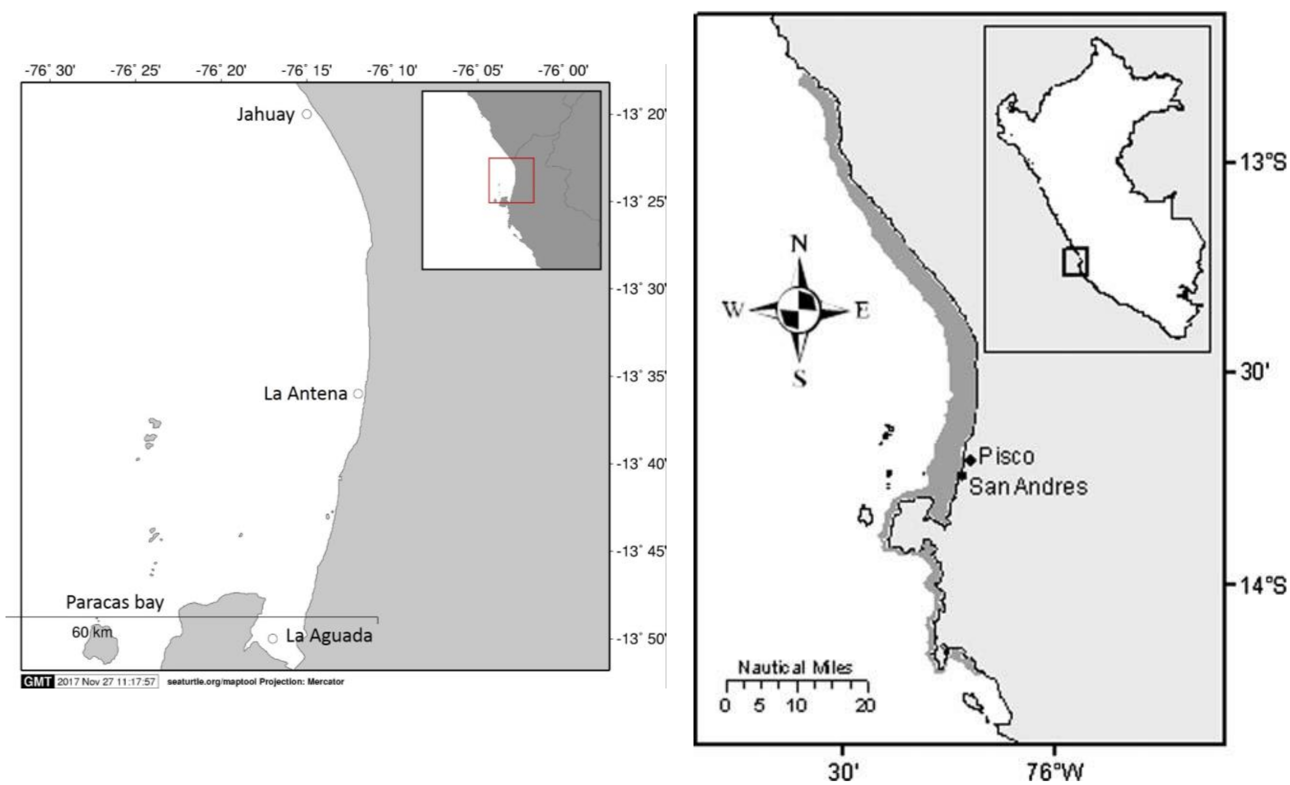


Figure 6. Principal foraging areas for *Chelonia mydas agassizii* identified in southern Perú (Ref 40, 35, de Paz pers. comm.).

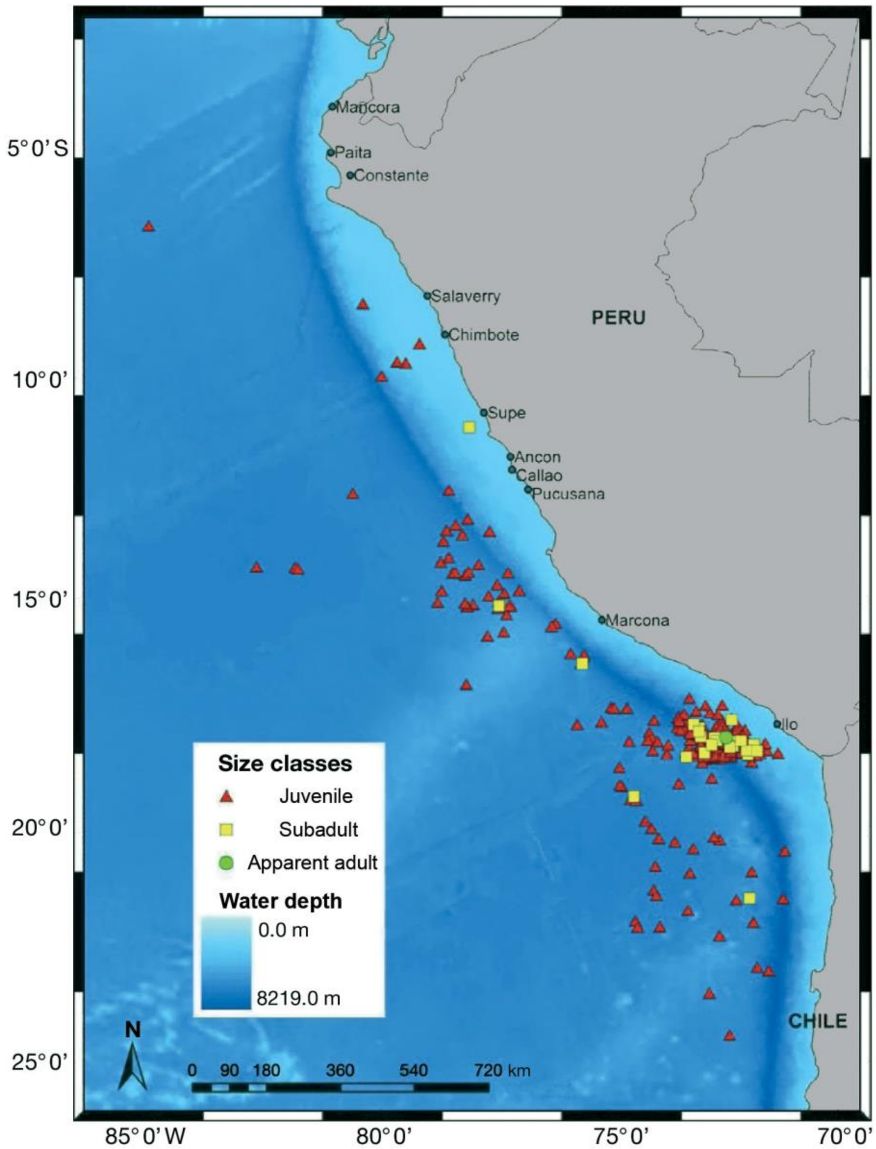


Figure 7. *Caretta caretta*. At-sea locations of loggerhead turtles captured off Peru (n = 299). Loggerhead turtles were grouped by curved carapace length size classes: juveniles (<70 cm), subadult (70 to 85 cm) and apparent adults (>85 cm) (Ref 1: Alfaro et al. 2008).

REFERENCES

1. Alfaro-Shigueto, J., Mangel, J., Seminoff, J., Dutton, P. H. 2008. Demography of loggerhead turtles Caretta caretta in the Pacific Ocean: fisheries-based observations and implications for management. Endangered Species Research 5: 129-135, 2008.
2. Alfaro-Shigueto, J., Dutton, P. H. Mangel, J., Vega, D. 2004. First Confirmed Ocurrence of Loggerhead Turtles in Perú. Marine Turtle Newsletter 103: 7-11.
3. Mangel, J. C., Alfaro-Shigueto, J., Witt, M. J., Dutton, P. H., Seminoff, J. A., Godley, B. J., 2011 Post-capture movements of loggerhead turtles in the southeastern Pacific Ocean assessed by satellite tracking. Marine Ecology Progress Series 433: 261-272.
4. Pajuejo, M., Bjornal, K. A., Alfaro Shigueto, J., Seminoff, J. A., Mangel, J. C., Bolten, A. B., 2010. Stable isotope variation in loggerhead turtles reveals Pacific Atlantic oceanografic differences. Marine Ecology Progress Series 417: 277 - 285.
5. Alfaro-Shigueto, J., Mangel, J., Bernedo, F., Dutton, P. H., Seminoff, J. A., Godley, B. J., 2011. Small-scale fisheries of Peru: a major sink for marine turtles in the Pacific. Journal of Applied Ecology. 48: 1432-1440.
6. Valqui, M., M. Pons, L. Rendón, S. Andraka, S. Amorós y M. Hall. 2016. Reducción de la captura incidental de tortugas marinas por la flota espinelera artesanal del Perú 2004-2009. Resumen del informe técnico. WWF-Perú/WWF LAC. 78 pp.
7. WWF-Perú. 2016. Guia para la adecuada manipulación y liberación de tortugas marinas en las pesquerias de espinel. Programa Marino de WWF-Perú.
8. El Peruano, 2014, Decreto Supremo que aprueba la actualización de la lista de clasificación y categorización de las especies amenazadas de fauna silvestre legalmente protegidas. DECRETO SUPREMO Nº 004-2014 MINAGRI.
9. Ortiz, N., Mangel, J. C., Wang, J., Alfaro-Shigueto, J., Pingo, S., Jimenez, A., Suarez, T., Swimmer, Y., Carvalho, F., Godley, B.J., 2016. Reducing green turtle bycatch in small-scale fisheries using illuminated gillnets: the cost of saving a sea turtle. Marine Ecology Progress Series. 545: 251-259.
10. El Peruano, 1995. Prohiben la captura dirigida de todas las especies de tortugas marinas existentes en aguas jurisdiccionales peruanas. Resolucion Ministerial Nr. 103-95-PE.
11. Aranda, C. A., Chandler, M. W., 1989. Las tortugas marinas del Perú y su situación actual. Boletin de Lima, No. 62.
12. Alfaro-Shigueto, Mangel, J. C., Dutton, P. H., Seminoff, J. A., Godley, J., 2012. Trading information for conservation: a novel use of radio broadcasting to reduce sea turtle bycatch. Fauna and Flora International, 46(3), 332 – 339.
13. Jimenez, A., Pingo, S., Alfaro-Shigueto, J., Mangel, J. C., Hooker, Y., 2017. Feeding ecology of the green turtle Chelonia mydas in northen Peru. Latin American Journal of Aquatic Research. 45(3): 585-596.
14. El Peruano, 2016. Aprueban plan maestro de la Reserva Nacional de Paracas, periodo 2016 - 2020. Resolución Presidencial Nr. 020-2016-SERNANP.
15. El Peruano, 2016. Aprueban plan maestro de la Reserva Nacional Sistema de Islas, Islotes y Puntas Guaneras, periodo 2016-2020. Resolución Presidencial Nr. 048-2016-SERNANP.
16. El Peruano, 2011. Decreto Supremo que aprueba la categorización de la Zona Reservada San Fernando como Reserva Nacional San Fernando. Decreto Supremo Nr. 017-2011-MINAM.
17. Alfaro-Shigueto, J. Mangel, J. C., Caceres, C., Seminoff, J. A., Gaos, A., Yañez, I. 2010. Hawksbill turtles in peruvian coastal fisheries. Marine Turtle Newsletter. 129: 19-21.

18. Vargas, P., P. Tello, and C. Aranda. 1994. Sea turtle conservation in Peru: the present situation and a strategy for immediate action. In: Proceedings of the Fourteenth Annual Symposium on sea turtle biology and conservation. NOAA Technical Memorandum NMFS-SEFSC-351: 159-162.
19. Pfaller, J. B., Alfaro-Shigueto, J., Giffoni, B., Ishihara, T., Mangel, J. C., Peckham, S. H., Bjorndal, K. A., Baeza, J. A., 2014. Social monogamy in the crab Planes major, a facultative symbiont of loggerhead sea turtles. Journal of Experimental Marine Biology and Ecology 461: 124-132.
20. Pingo, S., Jimenez, A., Alfaro-Shigueto, J., Mangel, J. C., 2017. Incidental capture of sea turtles in the artisanal gillnet fishery in Sechura Bay, northen Peru. Latin American Journal of Aquatic Research 45(3): 606-6014.
21. Alfaro-Shigueto, J. Mangel, J. C., Pajuelo, M., Dutton, P. H., Seminoff, J. A., Godley, B. J., 2010. Where small can have a large impact: Structure and characterization of small- scale fisheries in Peru. Fisheries Research. 106: 8-17.
22. Alfaro-Shigueto, J., Dutton, P. H., Van Bressem, M., Mangel, J. 2007. Interactions between leatherback turtles and peruvian artisanal fisheries. Chelonian Conservation and Biology 6(1): 129-134.
23. Suarez-Yana, T., Montes, D., Zuñiga, R., Mangel, J. C., Alfaro-Shigueto, J., 2016. Hematologic, morphometric and biochemical analytes of clinically healthy green sea turtles (Chelonia mydas) in Perú. Chelonian Conservation and Biology 15(1): 153-157.
24. Kelez, S., Velez-Zuazo, X., Pacheco, A. S., 2016. First record of hybridization between green Chelonia mydas and hawksbill Eretmochelys imbricata sea turtles in the Southeast Pacific. PeerJ. 4:e1712; DOI 10.7717/peerj.1712.
25. Gomez-Puerta, L. A., Bachmann, V., Quiñones, J., Quizpe, S., Torres, D., Macalupu, J., 2017. Primer reporte de Criocephalus albus (Digenea: Pronocephalidae) en el Perú, parásito de la tortugas verde del Pacífico Este (Chelonia mydas agassizii). Revista Peruana de Biología 24(2): 217-222.
26. Alfaro-Shigueto, J., Mangel, J., Forsberg, K., Ramanathan, A., Caceres, C., Dutton, P., Seminoff, J., Godley, J. 2009. Distribution of hawksbill turtles off Peru and implications for regional conservation efforts. Poster of 29th Annual Sea Turtle Symposium, Brisbane, Queensland, Australia.
27. Forsberg, K., 2009. Assesing sea turtle bycatch in North Peru: A community conservation iniciative. Poster of 29th Annual Sea Turtle Symposium, Brisbane, Queensland, Australia.
28. Forsberg, K., A. Petit & M. Arangüena. 2012. Avances en el estudio y monitoreo de anidación de tortugas marinas en el norte del Perú. Poster presentation. III Congreso de Ciencias del Mar del Perú 2012.
29. Vera, M., J. Llanos, E. Torres, C.A. Rosales, F. Van Oordt. 2010. Notas sobre neonatos de Lepidochelys olivacea (Testudines: Cheloniidae) en Playa Nueva Esperanza, Tumbes, Perú. Inf. Inst. Mar Perú. 37(3-4): 161-166.
30. Instituto del Mar del Peru - IMARPE, 2011. Informe nacional sobre la conservacion de las tortugas marinas en el Perú. Comision Permanente del Pacifico Sur - CPPS. 72p.
31. Rosales, C., A., Vera, M., Llanos, J., 2010. Varamientos y captura incidental de tortugas marinas en el litoral de Tumbes, Perú. Revista Peruana de Biología, 17(3): 293-301.
32. Instituto del Mar del Peru - IMARPE, 2010. Reporte de varamientos de mamíferos marions y quelonidos en el litoral de Tumbes (Octubre 2010). 7 p.
33. Forsberg, K., Casabonne, F., Castillo Torres, J., 2012. First evidence of green turtle nesting en Peru. Marine Turtle Newsletter, 133: 9-11.
34. Paredes, E., Kochzius, M., Quiñones, J., 2017. Ecology of the East Pacific green turtle (*Chelonia mydas*) at Virrila Estuary, northern coast of Peru: conservation and management implicartions.

Thesis submited in partial fulfillment for master degree in Marine and Lacustrine Science and Management. 66p.

35. Quiñones, J., Gonzales, V., Zeballos, J., Purca, S., Mianzan H., 2010. Effects of El Niño-driven environmental variability on black turtle migration to Peruvian foragin grounds. Hydrobiologia 645: 69-79.
36. Quiñones, J., Zeballos, J., Quispe, S., Delgado, L., 2011. Southernmost records of hawksbill turtles along the East Pacific Coast of South America. Marine Turtle Newsletter, 130: 16-18.
37. Quiñones, J., García-Godos, I., Llapapasca, M., Van Ordt, F., Paredes, E., 2015. The black sea turtle (Chelonia mydas agassizii) at Lobos de Tierra island, Northern Peru: High densities in small areas. South American Journal of Herpetology, 10(3): 178-186.
38. Quiñones, J., Quispe, S., Galindo, O., 2017. Illegal capture and black market trade of sea turtles in Pisco, Perú: the never-ending story. Latin American Journal of Aquatic Research, 45(3): 615-621.
39. Quiñones, J., Paredes, E., Quispe, S., Delgado, L. 2015. Sea turtles during 2010 in Pisco, Peru. Inf Inst Mar Perú 42(4): 516 -525.
40. Velez-Zuazo, X., Quiñones, J., Pacheco, A. S., Klinge, L., Paredes, E., Quispe, S., Kelez, S., 2014. Fast growing, healthy and resident green turtles (Chelonia mydas) at two neritic sites in the central and northern coast of Peru: Implications for Conservation. PLOS ONE, 9(11): 12p.
41. Vera, M., Rosales, C. A., 2012. Size structure of olive ridley turtle Lepidochelys olivacea (Testudines: Chelonidae) in Tumbes, Perú. Revista Peruana de Biología, 19(2): 175-180.
42. de Paz Campos, N., P. Díaz, M. Ormeño, P.H. Dutton, J.C. Reyes, E. Goya, M. Vera. 2016. From retaining releasing leatherbacks: A collaborative conservation initiative among fishermen and researchers in Peru. 36 Simposio Anual sobre la Biología y Conservación de Tortugas Marinas. Lima, Perú.
43. Kelez, S., Velez-Zuazo, X., Manrique, C., 2003. New evidence on the loggerhead sea turtle Caretta caretta (Linnaeus 1758) in Peru. Ecología Aplicada 2(1): 141-142.
44. Kelez, S., Velez-Zuazo, X., Manrique, C., 2003. Current status of sea turtles along the northern coast of Peru: Preliminary results. Poster Presentation 22nd Annual Symposium on Seaturtle biology and Conservation. Miami , Florida USA.
45. Kelez, S., Manrique, C., Velez-Zuazo, X., Williams de Castro, M., 2004. Green turtle (Chelonia mydas agassizii) diet diferences in two peruvian coastal localities. Poster Presentation from 21st Anual Sympossium on Sea Turtle Biology and Conservation, Philadelphia, Pennsylvania USA.
46. Kelez, S., C. Manrique, and X. Velez-Zuazo. 2006. Shark longline fishery and sea turtles in Peruvian waters. Pages 262-263 in M. Frick, A. Panagopoulou, A. F. Rees, and K. Williams, editors. Book of abstracts. Twenty Sixth Annual Symposium on sea turtle biology and conservation, Island of Crete, Greece.
47. Kelez, S., Velez-Zuazo, X., Angulo, F., 2008. El registro más sur de anidación de tortugas marinas en Perú in Kelez, S., van Oordt, F., de Paz, N., Forsberg, K (Editors) Libro de Resumenes II Simposio de Tortugas Marinas en el Pacifico Sur Oriental, Lima-Perú p. 96.
48. Kelez, S., Velez-Zuazo, X., Manrique, C., Ayala, L., Amoros, S., Sanchez, S., 2008. Captura incidental de tortugas marinas en la pesca con palangre en Perú in Kelez, S., van Oordt, F., de Paz, N., Forsberg, K. (Editors) Libro de Resumenes II Simposio de Tortugas Marinas en el Pacifico Sur Oriental, Lima-Perú. p. 59-60.
49. Kelez, S., Velez-Zuazo, X., Angulo, F., Manrique, C., 2009. Olive ridley Lepidochelys olivacea nesting in Peru: The southernmost records in the Eastern Pacific. Marine Turtle Newsletter, 126: 5-9.
50. Manrique, C., Kelez, S., Velez-Zuazo, X., 2002. Hatchlings in Peru: the first headstarting experience in Seminoff, J. A., compiler. Proceedings on the Twenty-Second Annual Symposium

on Sea Turtle conservation on Sea Turtle Biology and Conservation, NOAA Technical Memorandum NMFS-SEFSC p.99.

51. Manrique, C., Kelez, S., Velez-Zuazo, X., 2006. Impact of the common dolphinfish longline fishery on sea turtles along the peruvian coast between 2003 and 2005 in Frick, M., Panagopoulou A., Rees, A. F. and Williams, K. (compilers). 2006. Book of Abstracts Twenty Sixth Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Athens, Greece, p. 236.
52. Velez-Zuazo, X., S. Kelez, and C. Manrique. 2006. Genetic composition of sea turtles bycatch from Peruvian fisheries: results of mtDNA analysis. Page 207 in M. Frick, A. Panagopoulou, A. F. Rees, and K. Williams, editors. Book of Abstracts. Twenty Sixth Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Athens, Greece.
53. Velez-Zuazo, X., and S. Kelez. 2010. Multiyear analysis of sea turtle bycatch by Peruvian longline fisheries: a genetic perspective. 30th Annual Symposium on Sea Turtle Biology and Conservtion, Goa, India.
54. Torres, D., Castañeda, J., Quiñones, J., Sarmiento, D., 2016. Sea turtle strandings in the Lambayeque shoreline, North Peru. Poster Presentation from 36th Anual Sympossium on Sea Turtle Biology and Conservation, Lima-Peru.
55. Sarmiento, D., Jimenez, A., Pingo, S., Fiestas, M., 2016. Asociacion amigos de la naturaleza: San Jose, a coastal community guarding for the marine environment. Poster Presentation from 36th Anual Sympossium on Sea Turtle Biology, Lima-Peru.
56. Alfaro-Shigueto, J., 2016. Disminución de impactos de redes de cortina en tortugas marinas con énfasis en dorso de cuero. Informe técnico para WWF-Perú. 21pp.
57. Santillán, L. A., 2008. Analisis de la dieta de Chelonia mydas agassizii “Tortuga verde del Pacifico” en la Bahia de Sechura, Piura – Peru. Tesis Grado Magíster Scientiae. Universidad Nacional Agraria La Molina.
58. Zavala, A., Kelez., 2015. Sea turtle nesting in Perú: using citizen science and public participation to reveal overlooked nesting activity in the northnern coast in Visconti, P., Game, E., Mathevet R., Wilkerson M. Proceedings of the 27th International Congress for Conservation Biology and 4th European Congress for Conservation Biology. Montpellier 2-6 August 2015. SCB; 2015.
59. Boyle M., Fitz Simmons N., Limpus C., Kelez S., Vélez-Zuazo X. y M. Waycott. 2009. Evidence for transoceanic migrations by loggerhead sea turtles in the southern Pacific Ocean. Proc R Soc. B. 276 (1664):1993-1999.
60. Resolución Ministerial Nº 1386-2015-Produce/DGS.
61. Kelez, S., Actividad de anidacion de tortugas marinas por playas, base de datos ecOceanica (Periodo 2012-2016) RAW DATA.
62. Calvo, C., Pereda, A., Guzmán, F., Marquez, S., Díaz, S., Peña, S. 2017. Informe de varamiento de tortugas marinas en la costa de La Libertad, Perú entre enero y febrero de 2017 Grupo de Rescate de Animales Marinos. 7pp.
63. Arthur, K E, S Kelez, T Larsen, C A Choy, & B N Popp. 2014. Tracing the biosynthetic source of essential amino acids in marine turtles using δ13C fingerprints. Ecology 95(5): 1285-1293
64. El Peruano, 2004. Aprueban categorización de especies amenazadas de fauna silvestre y prohiben su caza, captura, tenencia, transporte o exportación con fines comerciales. Decreto Supremo Nr. 034-2004-AG.
65. de Paz, Reyes, J., Echegaray, E. 2002 Catches, Trade and biology of marine turtles in the fishing area of Pisco - Paracas in Mendo, J., Wolf, M., editors. 2002. Memorias 1 Jornada Científica Reserva Nacional Paracas. Universidad Nacional Agraria La Molina 244 pp.
66. de Paz, N; Díaz, P., Valqui, M., Cruz, A. and Gomez, F. 2010. Preliminary data on Sea turtles bycatch on longline fisheries of the Peruvian artisanal vessels: Distribution & Population Structure. Pag. 207. En Dean, Kama & Lopez- Castro, Melania C.,compilers. Proceedings of the

Twenty-eigth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NOAA-NMFS-SEFSC-602.

67. Castro, J., de la Cruz, J., Ramírez, P., & Quiñones, J. (2012). Captura incidental de tortugas marinas durante El Niño 1997-1998, en el norte del Perú. Latin American Journal of Aquatic Research, 40(4), 970–979. http://dx.doi.org/10.3856/vol40-issue4-fulltext-13
68. Zavala, A. & S. Kelez. 2017. Anidación de tortugas marinas en el Perú. VI Simposio Regional sobre Tortugas Marinas en el Pacifico Sur Oriental.
69. Ayala, L., & Sánchez-Scaglioni, R. 2014. Captura, esfuerzo y captura incidental de la pesca con espinel en el centro de Perú. Revista peruana de biología, 21(3), 243-250.
70. Zavala, A. & S. Kelez. 2019. Sea turtle nesting in Peru. In: Mangel, J.C., Rees, A., Pajuelo, M., Córdova, F, Acuña, N. compilers. Proceedings of the Thirty-Sixth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NOAA NMFS-SEFSC-734: 303-304.
71. Lester-Coll, A., X. Velez-Zuazo, S. Kelez, J. Quiñones, J. Alfaro-Shigueto, J. C. Mangel, y R. Papa. 2014. Diversidad genetica, estructura y origen de las tortugas verdes en habitats neriticos en Peru. IV Congreso Nacional de Ciencias del Mar (CONCIMAR).
72. Kelez, S. 2011. Bycatch and foraging ecology of sea turtles in the Eastern Pacific. PhD Dissertation, Duke University. Available: http://dukespace. lib. duke. edu/dspace/bitstream/handle/10161/5642/KelezSara_duke_0066D_10996. pdf.
73. Paredes, E., J. Quiñones, S. Quispe & V. Bachmann. 2015. Black and hawksbill turtle strandings in estuarine waters in the peruvian Northern coast. In: Y. Kaska, B. Sonmez, O. Turkecan & C. Sezgin (eds.). Book of Abstracts of 35thAnnual Symposium on Sea Turtle Biology and Conservation. Macart Press, Turkey, 250 pp.
74. Gonzalez, C & S.Kelez. 2017. En busca de la tortuga carey en el Peru. VI Simposio Regional sobre Tortugas Marinas en el Pacífico Sur Oriental.
75. Gonzalez, C & S.Kelez. 2016. Where are the aggregation areas of the Critically Endangered hawksbill turtle (Eretmochelys imbricata) in Peru?. Poster Presentation from 36th Anual Sympossium on Sea Turtle Biology and Conservation, Lima-Peru.
76. Gaos AR et al. 2017.Natal foraging philopatry in eastern Pacific hawksbill turtles. R. Soc. open sci. 4: 170153. http://dx.doi.org/10.1098/rsos.170153.
77. Acuña et al.2015. Satellite tracking of hawksbill turtles (Eretmochelys imbricata) in Sechura Bay, Peru. Poster presentacion from 35th Anual Sympossium on Sea Turtle Biology and Conservation,Dalaman-Turkey.
78. Kelez, S & Velez-Zuazo X. 2014. Sea Turtle Nesting Expansion into Peru Bring s New Management Challenges, SWOT Report, SeaTurtleStatus.org.
79. Quiñones, J., J. Alfaro-Shigueto, E. Paredes, J. Mangel & S. Quispe. 2015. Jellyfish abundance and Kelvin waves drive juvenile and sub adult leatherback presence in Peru-vian neritic waters. Thirty Five Annual Symposium on Sea Turtle Biology and Conservation. Lima, Dalaman Mugla, Turquia.
80. Quiñones, J., Paredes, E. y Quispe, S. 2013. Ocurrencia de tortugas marinas, parámetros biológicos y ecología alimentaria en la zona de Pisco. En libro de resúmenes del XXXIII Congreso de Ciencias del Mar, Antofagasta, Chile 175p.
81. Quiñones, J., Zeballos, J., Quispe, S. y J. Alfaro-Shigueto. 2009. Captura incidental de la tortuga dorso de cuero (Dermochelys coriacea) durante el fenómeno El Niño 1987 en San Andrés, Perú: Posibles causas e implicaciones. Resumen presentado al III Simposio de Tortugas Marinas en el Pacífico Sur Oriental. Santa Elena, Ecuador.
82. Quiñones, J., Zeballos, J., Quispe, S. 2010. Uso ilegal de tortugas Marinas en San Andrés Pisco para consumo humano Noviembre 2009 – Abril 2010. Libro de resúmenes II Congreso de Ciencias del Mar del Perú. Piura, Junio 2010.

83. Quiñones, J., Quispe, S., de Paz, N., Kelez, S. and Velez-Zuazo, X. En prensa. Mortality, ilegal captures and black market of sea turtles in San Andres, Pisco, Peru. In Proceedings of the Thirty-Second Annual Symposium on Sea Turtle Biology and Conservation, Bahias Huatulco, Mexico, April 2012.
84. Quiñones J, S. Quispe, E. Paredes, 2019. Black Turtle Population Dynamics in Paracas, Peru during a six year in water monitoring, Proceedings of the Thirty Six Annual Symposium on Sea Turtle Biology and Conservation. Lima, Peru, March 2016.
85. Quispe S, J. Quiñones, E. Paredes, 2019. Ilegal captures of sea turtles and black market using information from dumpsites and strandings in San Andres, Pisco, Peru, Proceedings of the Thirty Six Annual Symposium on Sea Turtle Biology and Conservation. Lima, Peru, March 2016.
86. Romero, C. & J. Quiñones, 2016. Epibiontes de la tortuga verde (Chelonia mydas agassizii) como indicadores de los estadios de vida y distribución geográfica en Peru. Resumenes Congreso Nacional de Ciencias del Mar, CONCIMAR, Lambayeque, 2016.
87. Paredes, E. and Quiñones, J. 2013. Leatherback and gillnet interactions off Peru, highlighting in coastal bycatch. In Tucker, T., Belskis, L., Panagopoulou, A., Rees, A., Frick, M., Williams, K., LeRoux, R., and Stewart, K. compilers. Proceedings of the Thirty-Third Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NOAA NMFS-SEFSC-645: 263 p.
88. Paredes, E., J. Quiñones, J. de la Cruz & P. Ramirez, 2014. Sea turtles set a new southernmost nesting record at the Eastern Pacific. Proceedings of the Thirty-Four Annual Symposium on Sea Turtle Biology and Conservation, New Orleans, USA.
89. Paredes, E. and Quiñones, J. 2012. Feeding ecology of the East Pacific green turtle (Chelonia mydas agassizii) in the feeding area of Paracas bay, Peru. In Proceedings of the Thirty-Second Annual Symposium on Sea Turtle Biology and Conservation.
90. Paredes & Quiñones, 2016. Sea Turtles at the Virrila Estuary, Northern Coast of Peru: Threats and implications for conservation, Student Conference on Conservation Science, Cambridge. United Kingdom (UK).
91. Peavey, LE, BN Popp, RL Pitman, SD Gaines, KE. Arthur, S Kelez, & JA Seminoff. 2017. Opportunism on the high seas: foraging ecology of olive ridley turtles in the eastern Pacific Ocean. Front. Mar. Sci. 4:348. doi:10.3389/fmars.2017.00348
92. Quiñones, J., S. Quispe, V. Bachmann, E. Paredes, M. Manrique, 2018. Plastic in diet contents of East Pacific Green Turtle (Chelonia mydas agassizii) in Northern and Central Peru, First Microplastic Workshop, Plymouth University (UK) and IMARPE, Octubre, 2018, Callao.
93. de Paz, N., Reyes, J.C., Ormeño, M., Anchante, H.A., Altamirano, A.J. 2006. Immature leatherback mortality in coastal gillnet fisheries off San Andres, Southern Peru. In: Frick, M., Panagopoulou, A., Rees, A.F., Williams, K. (Eds.), Twenty Sixth Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Crete, p. 376.
94. Dutton, P.H., La Casella, E.L., Alfaro-Shigueto, J., Donoso, M. & N. de Paz. 2010. Stock origin of leatherback (Dermochelys coriacea) foraging in the southeastern Pacific. Proceedings of the 30th Annual Symposium on sea turtle biology. In Blumenthal, J., Panagopoulou, A., and Rees, A. F., compilers. 2013. Proceedings of the Thirtieth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-640. p 91.
95. Alfaro-Shigueto, J., Mangel, J., Donoso, M., Marquez, J.C. 2009. Summary of gillnet fisheries and sea turtle's interactions in peru and Chile. Proceedings of the technical workshop on mitigating sea turtle bycatch in coastal net fisheries. Honolulu, Hawaii, USA.
96. Mangel J. 2018. ProDelphinus Peru Leatherback Tracking Project. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1330) on 2019-04-30 and originated from Satellite Tracking and Analysis Tool (STAT; http://www.seaturtle.org/tracking/index.shtml?project_id=546).

97. Shillinger, G. L., Palacios, D. M., Bailey, H., Bograd, S. J., Swithenbank, A. M., Gaspar, P. Wallace, B. P., Spotila, J. R., Paladino, F. V., Piedra, R., Eckert, S. A., and Block, B. A. 2008 Persistent leatherback turtle migrations present opportunities or conservation. PLoS Biology 6:e171.
98. Shillinger, G. L., A. M. Swithenbank, H. Bailey, S. J. Bograd, M. R. Castelton, B. P. Wallace, J. R. Spotila, F. V. Paladino, R. Piedra, and B. A. Block. 2011. Vertical and horizontal habitat preferences of post-nesting leatherback turtles in the South Pacific Ocean. Marine Ecology Progress Series 422:275–289.
99. Dutton, P.H., La Casella, E.L., Alfaro-Shigueto, J., de Paz Campos, N., Donoso, M. & J. Mangel. 2019. Stock origin of leatherback, loggerhead and green turtles foraging in the southeastern pacific: insights into their trans-oceanic connectivity. In Mangel, J.C., Rees, A., Pajuelo, M., Córdova, F, Acuña, N. compilers. Proceedings of the Thirty-Sixth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NOAA NMFS-SEFSC-734. 311 p.
100. Limpus, C.J. & Limpus, D.J. 2003. Loggerhead turtles in the equatorial and southern Pacific Ocean. In: Bolten, A.B. & Witherington, B.E. (eds) Loggerhead sea turtles. Smithsonian Books, Washington, DC, p 199–209.
101. SERFOR. 2018. Libro Rojo de la Fauna Silvestre Amenazada del Perú. Primera edición. Serfor (Servicio Nacional Forestal y de Fauna Silvestre), Lima, Perú, pp 1- 548.
102. Valqui, M., Cruz, A., Alfaro Shigueto, J., Kelez Sara, S., Pajuelo, M., Mangel, J. & Melly, P. 2006. First year results of the hook substitution experiment to reduce sea turtle bycatch in Peru. Abstract, 26th Annual Symposium on Sea Turtle Biology and Conservation. International Sea Turtle Society, Athens, Greece.
103. Hays-Brown C, Brown WM. 1982. Status of sea turtles in the Southeastern Pacific Emphasis on Peru. Pages 235-240 En K. A. Bjorndal, editor. Biology and conservation of Sea Turtles. Smithsonian Institution Press.
104. Paredes Coral, E. 2015. Hábitos alimentarios de la tortuga verde del Pacífico este Chelonia mydas agassizii (Boucort, 1868) en la bahía de Paracas, Ica, Perú, durante el año 2010. Tesis. Universidad Nacional Mayor de San Marcos.
105. Quiñones, J., Bachmann, V., Chauca, J., Quispe, S. 2018. Informe anual del Proyecto de Monitoreo de Tortugas Marinas en El Estuario de Virrila, Instituto del Mar del Peru.
106. Sarmiento, D., Alfaro-Cordova, E., Fiestas, J., Fiestas, J. 2016. Captura y Liberacion de tortugas marinas por pescadores artesanales de San Jose, Poster Congreso Nacional de Ciencias del Mar, Lambayeque, 2016.
107. Paredes, R. 1969. Introducción al estudio biológico de Chelonia mydas agassizii en el perfil Pisco. Tesis. Universidad Nacional Federico Villareal, Lima.83 p.
108. Bielli, A., J. Alfaro-Shigueto, P.D. Doherty, B.J. Godley, C. Ortiz, A. Pasara, J.H. Wang, J.C. Mangel. 2020. An illuminating idea to reduce bycatch in the Peruvian small-scale gillnet fishery. Biological Conservation 241. https://doi.org/10.1016/j.biocon.2019.108277
109. Aguilar Arakaki, R., M.A. Llapapasca Lloclla, J. Quiñones Dávila, S.B. Rivadeneyra Villafuerte, D. Torres Negreiros. 2020. Depredadores superiores en Isla Lobos de Tierra, Peru. Evaluacion de Linea de Base (GEF-UNDP 2014). Inf Inst Mar Perú 47(1): 37-64.

CHAPTER 10 CHILE

Updated 2020

Rocío Álvarez-Varas[1,2,3], Carol Medrano[2], Patricia Zárate[4], Juan Carlos Ortíz[5], Walter Sielfeld[6], Paula Salinas-Cisternas[6], Mauricio Ulloa[7]

[1] Universidad de Chile, Casilla 653, Ñuñoa, Santiago, Chile

[2] Qarapara Tortugas Marinas Chile NGO, El Capitel 3314, Puente Alto, Santiago, Chile

[3] Núcleo Milenio Ecología y Manejo Sustentable de Islas Oceánicas (ESMOI), Universidad Católica del Norte, Coquimbo, Chile

[4]Instituto de Fomento Pesquero, Blanco 839, Valparaíso, Chile

[5]Universidad de Concepción, Barrío Universitario s/n, Concepción, Chile

[6]Tortumar-Universidad Arturo Prat, Av. Arturo Prat 2120, Iquique, Chile

[7]Unidad de Rescate, Rehabilitación y Conservación de Especies Protegidas (URCEP)/SERNAPESCA, Victoria 2832, Valparaíso, Chile, Chile

General remarks

Chile represents a foraging habitat for five sea turtle species: leatherback turtle (*Dermochelys coriacea*), Olive ridley turtle (*Lepidochelys olivacea*), green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*) and loggerhead turtle (*Caretta caretta*) (Ref 77). All species have been reported in the mainland and insular territory, except the hawksbill turtle that was described exclusively for Easter Island in 2015 (Rapa Nui) (Ref 1).

Among the threats towards sea turtle populations in Chile we have bycatch associated with different types of fisheries (Ref 14, 16, 17, 18, 38, 39, 40, 74, 101, 103, 104), marine pollution including plastic (Ref 53, 93) and chemicals (e.g. heavy metals) (Ref 4), coastal development (Ref 4), boat strikes (Ref 2), predation by other vertebrates (i.e. sea lions; Ref 52, 55, 57, 67, 104), diseases (Ref 7), and intentional killing that has been reported in some exceptional cases (Ref 2, 9, 27, 35, 77). Most of these threats together with syndromes associated with low water temperature have led to sea turtle strandings along

the Chilean coast; events that are mainly occurring in north-central Chile and during cold months (Ref 78).
Several efforts have been carried out by the Chilean government to protect and conserve sea turtle populations and their habitats in Chile. In 1995, an extractive fishing ban for 30 years was established on birds, mammals and marine reptiles, including sea turtles (Ref 20, 32). Later in 2010, Chile subscribes to the Inter American Convention for the Protection and Conservation of Sea Turtles (IAC) and in the same year the Sea turtle Chilean Working Group (GTTM) was set up to advise the government on matters regarding sea turtles and to elaborate the National Action Plan for these species (Ref 99). This Plan comprises the guidelines for research and conservation actions for the sea turtles throughout the country. The GTTM is headed by the Chilean Undersecretary of Fishing and Aquaculture (SUBPESCA, Subsecretaría de Pesca) and the Fisheries Development Institute (IFOP, Instituto de Fomento Pesquero) and comprised representatives of governmental, national universities and non-governmental organizations (NGOs). Since the creation of the GTTM, the five sea turtle species have been classified according to their conservation status by the Environment Ministry of Chile (MMA, Ministerio de Medio Ambiente) through the Species Classification Regulation (RCE, Reglamento para la Clasificación de Especies; D. Ex. Nº 29, 2011).

In 2009, a stranding network was created by the National Fisheries Service (SERNAPESCA; Servicio Nacional de Pesca y Acuicultura), which records stranding data along the Chilean coast and ensures the necropsy, as far as possible, and the appropriate collection and distribution of samples between researchers and projects for future research (Ref 3, 78).

Conservation efforts and research have been developed by government and private initiatives including universities and NGOs. These efforts have been focused on generating knowledge on biology, ecology, health, and threats towards sea turtles in Chilean waters; assessing strategies to quantify and decrease bycatch; recording strandings; rehabilitation and reintroduction of individuals to their natural environment, and also educating and promoting community awareness. Furthermore, specifically in northern Chile, proposals have been elaborated to protect specific marine areas that have been threatened by anthropogenic activities such as La Puntilla in Chinchorro Beach (Arica), and Bahía Salado (Atacama) (Ref 4, 76, 87). The actions developed by IFOP include recording and monitoring bycatch, reinforcing good practices, and assessment of mitigation measures for fisheries that capture sea turtles (Ref 104).

In the context of marine pollution, in 2007 the Universidad Católica del Norte created the citizen science program called "Científicos de la Basura" (“Garbage Scientists”) that together with scholar children and teachers apply the scientific method to investigate and mitigate the garbage problem in the Chilean coast. Although the impact of this program on sea turtle populations has not been evaluated directly, it has significantly contributed to social awareness about this global concern. This increased awareness led to a ban on the use of plastic bags in large stores in early 2019 in Chile (Ley N°21100, MMA). Although much remains to be done, all these efforts have been a significant contribution to the knowledge and conservation of sea turtle populations and their habitats in Chile during the last fifteen years.

This report comprises information retrieved from scientific publications, book chapters, technical reports, and proceedings of scientific events. Furthermore, information on monitoring programs, institutions and NGOs related to sea turtle conservation in Chile is included.

1. RMU *Dermochelys coriacea* Eastern Pacific Ocean (DC-EPO)

1.1. Distribution, abundance, trends

The leatherback turtle has a circumglobal distribution and Chilean populations correspond to the Eastern Pacific subpopulation or Regional Management Unit (RMU; Wallace et al. 2010), whose rookeries are distributed between Mexico and Central America with few nesting occurring in Colombia and Ecuador (Bailey et al. 2012; Shillinger et al. 2008; Ref 101, 103, 104).

1.1.1. Nesting sites

There are not nesting sites in Chile.

1.1.2. Marine areas

In Chile, there are sightings of leatherbacks as far as Bio Bio Region (39°28'59'', Shillinger et al. 2008, Wallace et al. 2010, Bailey et al. 2012, Ref 40, 66, 101, 103, 104). A great part of records come from bycatch associated with the industrial and artisanal longline fisheries; however, this type of fishing gear, since 2018, is no longer used in Chile (Ref 102). Today, most records of leatherbacks are associated with gillnets and to a lesser extent with longline and purse seine in the north of the country (Ref 102).

1.2. Other biological data

Genetic studies carried out by the IFOP with samples from leatherback turtles recovered from bycatch, show the Chilean population has its origin mainly in the Eastern Pacific region. However, also there is evidence suggesting a natal origin from the Western Pacific (Ref 103, 104); which supports Trans-Pacific migrations.

According to trophic ecology studies using stable isotopes (also developed by the IFOP), leatherback in Chile occupies a different trophic level than other species such as loggerhead and olive ridley turtle (Ref 101, 103, 104).

1.3. Threats

1.3.1. Nesting sites

There are not nesting sites in Chile.

1.3.2. Marine areas

The leatherback is the species most affected by bycatch in Chilean territory; especially by gillnets throughout Chile (Figure 1) and to a lesser extent in the longline fisheries targeting mahi-mahi (*Coryphaena Hippurus*) and pelagic sharks as well as in purse seine targeting small pelagic fishes in the exclusive economic zone (EEZ) (Ref 41, 66, 104) (See Table 1).

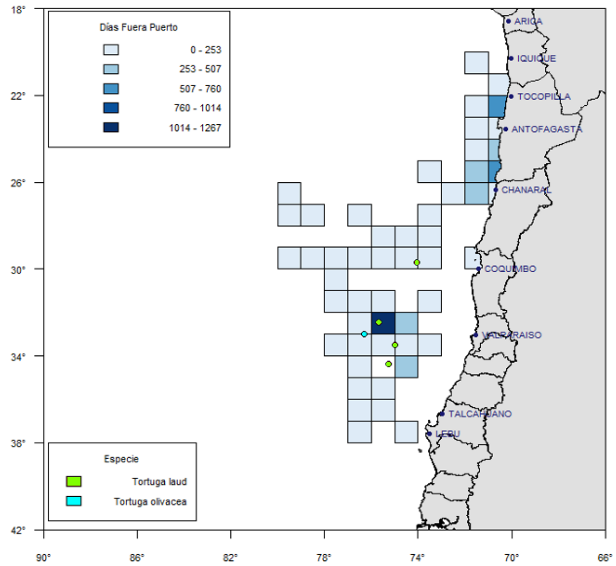


Figure 1. Spatial distribution of interaction between sea turtles (leatherback and Olive ridley turtle; green and light blue, respectively) and the artisanal gillnets fleet (days out of port), which operated during 2016 (Ref 101).

There are records of leatherbacks in industrial and artisanal surface longline fisheries from Talcahuano towards the north (Figure 2) (Ref 14, 16, 17, 18, 38, 39, 40, 48, 101, 103, 104). However, as previously mentioned, its use has been discontinued in Chilean fisheries.

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 (Ref 22, Miguel A. Mansilla pers. comm.). Items most commonly found in stomachs or intestines are plastic fragments and bags (Ref 22).

1.4. Conservation

Dermochelys coriacea has been classified as Critically Endangered species by the RCE in 2015 (D.S. Nº 16, 2016; MMA). During 2015, ONG Pacifico Laud supported by the NOAA (National Oceanic and Atmospheric Administration) carried out a pilot study to assess the impact of using various colors and ultra-violet light-emitting diodes (LEDs) on the drift gillnet fishery operating out of Chilean ports. Their results showed significant reductions in sea turtle bycatch, without notable negative effects on target catch (Ref 43). Currently, the IFOP is evaluating mitigation actions for bycatch associated with gillnets and longline targeting mahi-mahi (*Coryphaena Hippurus*) (Ref 66, 104) (See Table 1).

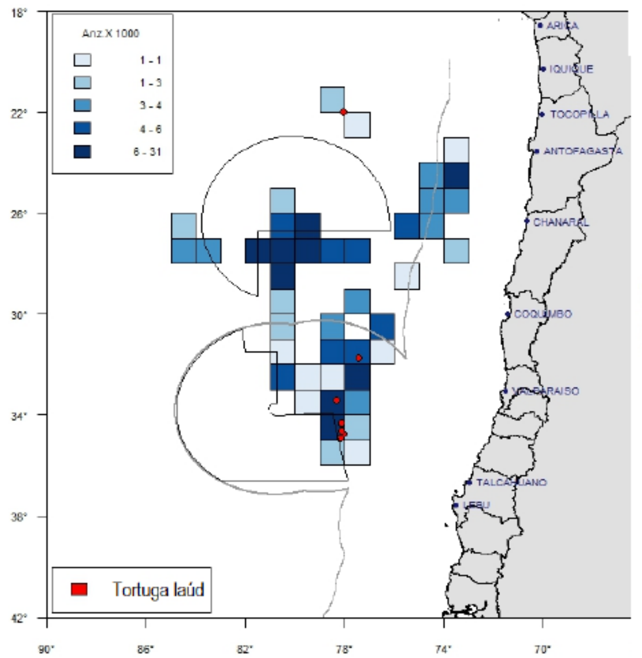


Figure 2. Spatial distribution of interaction between leatherbacks and the surface longline fleet (artisanal and industrial; hooks set), which operated on swordfish during 2018 (Ref 104).

1.5. 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 (Ref 104). Studies include the assessment of the trophic chain and the role of leatherbacks on it. This information will be incorporated into the National Action Plan for sea turtle conservation in Chile.

2. RMU *Chelonia mydas* Eastern Pacific Ocean (CM-EPO)

2.1. Distribution, abundance, trends

The green sea turtle is a cosmopolitan species distributed in tropical, subtropical and temperate waters of the Pacific, Atlantic and Indian Ocean (Seminoff et al. 2015). Its populations in mainland Chile are part of the North-Central/Eastern Pacific Lineage (Ref 4, 10, 98). Part of this lineage is also known as the black turtle; whose rookeries are restricted to the Eastern Pacific region and constitute the Eastern Pacific Population Segment (DSP; Wallace et al. 2010; Seminoff et al. 2015).

2.1.1. Nesting sites

There are not nesting sites in Chile.

2.1.2. Marine areas

Although there are isolated records of this species along the Chilean coast (as far as Desolation Island, 52º57′ S, 74°05′ W; Ref 58) its higher abundance is concentrated in northern Chile, where individuals aggregate to feed. To date, six foraging grounds have been identified in the mainland territory: Playa Chinchorro (Arica and Parinacota Region), Bahía Chipana (Tarapaca Region); Bahía Mejillones del Sur (Antofagasta Region), Caleta Constitución (Antofagasta Region), Poza Histórica de Antofagasta (Antofagasta Region) and Bahía Salado-Playa La Hedionda (Atacama Region) (Figure 3) (Ref 80). In insular Chile, specifically Rapa Nui (Easter Island) two aggregation areas of this species have been described (Figure 4) (Ref 1, 50, 73). However, in this place, it is possible to find turtles from both Pacific lineages: North-Central/Eastern Pacific Lineage and South-Central/Western Pacific Lineage (Ref 10). Turtles for the last lineage are often a lighter color and its rookeries are restricted to the Western and South-Central Pacific region (Ref 10).

2.2. Other biological data

Some studies in this species have reported the presence of epibiont including molluscs (gastropods and bivalves), crustaceans (amphipods, gammarids and cirripeds), algae, and hidrozoe (Ref 46, 68, 82).

Genetic studies carried out in mainland Chile indicate this species has its natal origin mainly in rookeries from Galapagos Archipelago and in lesser extent in Michoacán, Mexico, and Costa Rica (Ref 4, 42, 45, 98, 104). In contrast, Rapa Nui hosts individuals with multiple natal origins including Eastern Pacific, and south-central and Western Pacific rookeries (Ref 10).

Trophic ecology research focused on mainland turtles suggests this species occupies a lower trophic level in comparison with other sea turtle species (Seminoff et al. 2016; Ref 59, 101, 103, 104). For the case of Bahia Salado-Playa La Hedionda, stable isotopic studies suggest a diet based on seagrass and macroalgae (Ref 30).

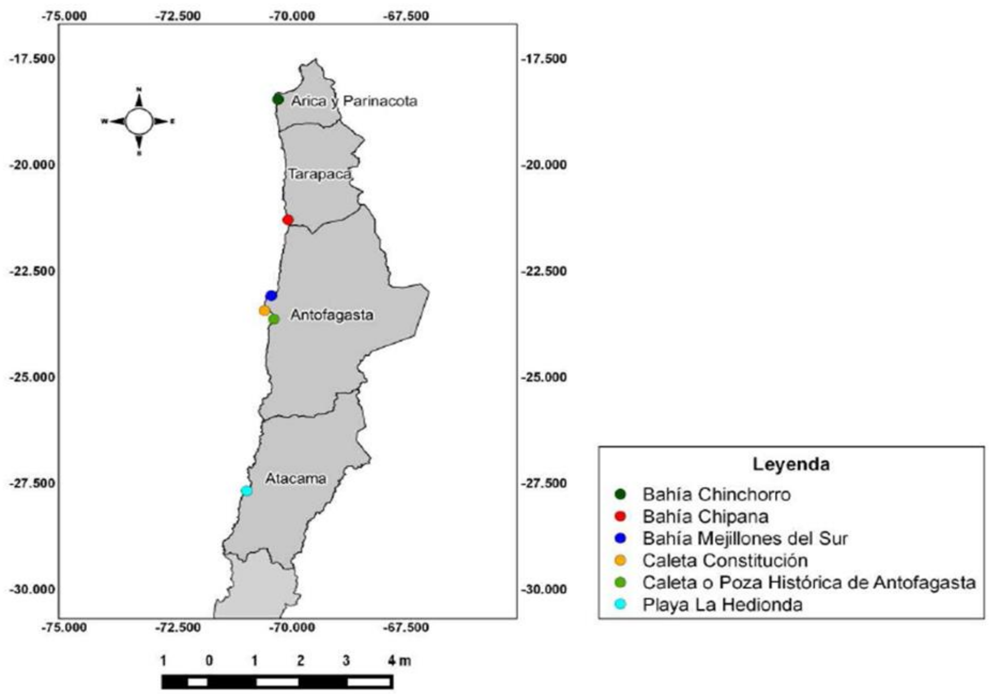


Figure 3. Foraging grounds of *Chelonia mydas* identified in mainland Chile.

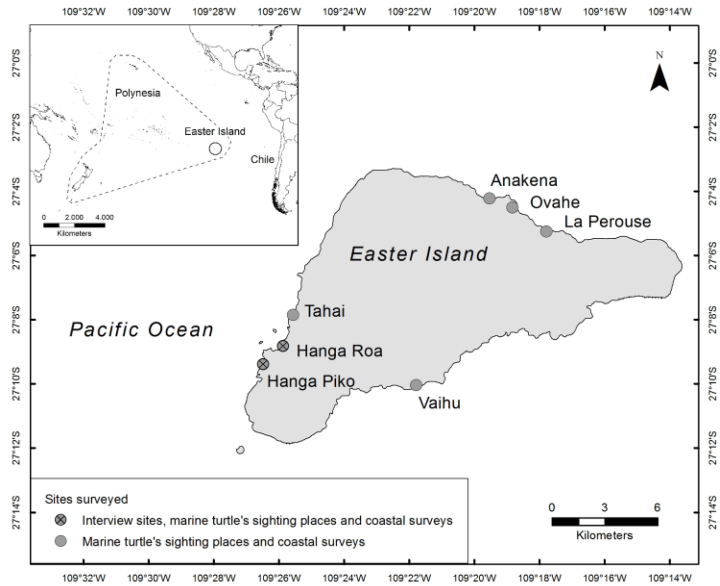


Figure 4. Map of Easter Island (Rapa Nui) showing its location on the South Pacific Ocean. The figure shows green turtle foraging grounds (turtle-sighting places; Álvarez-Varas et al. 2015).

2.3. Threats

2.3.1. Nesting sites

There are not nesting sites in Chile.

2.3.2. Marine areas

Mostly bycatch data are part of the "Observers on Board Program" implemented by the IFOP. *C. mydas* is mainly caught by the artisanal longline (small-scale longline with an average of 500 hooks) targeting mahi-mahi (*Coryphaena hippurus*) (Figure 5) and the pelagic blue (*Prionace glauca*) and mako shark (*Isurus oxyrinchus*) (Figure 6) (Ref 100, 101, 103, 104). For industrial fishery, *C. mydas* is the species with a smaller proportion of bycatch in Chile, and the captures are mainly associated with longline which is no longer used (Ref 13, 14, 16, 17, 18, 101, 103, 104) (See Table 1).

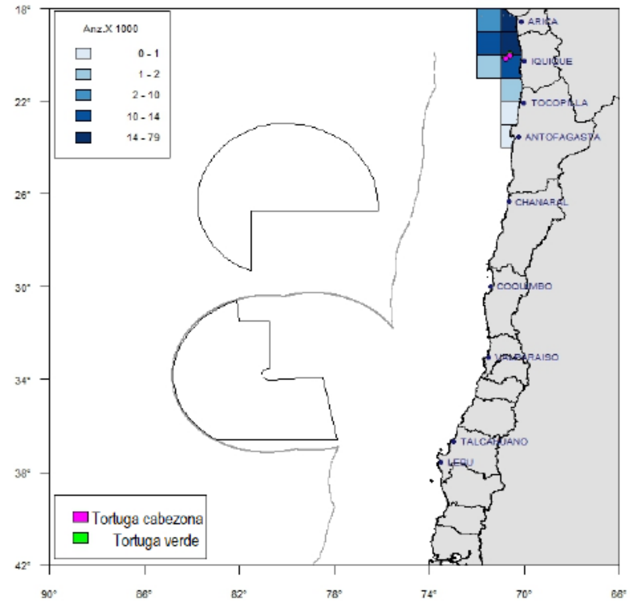


Figure 5. Spatial distribution of interaction between sea turtles (loggerhead and Olive ridley turtles, pink and green, respectively) and the artisanal longline (espinel in Spanish) fleet effort (hooks set), which operated on common dolphinfish (mahi-mahi) during 2018 (Ref 104).

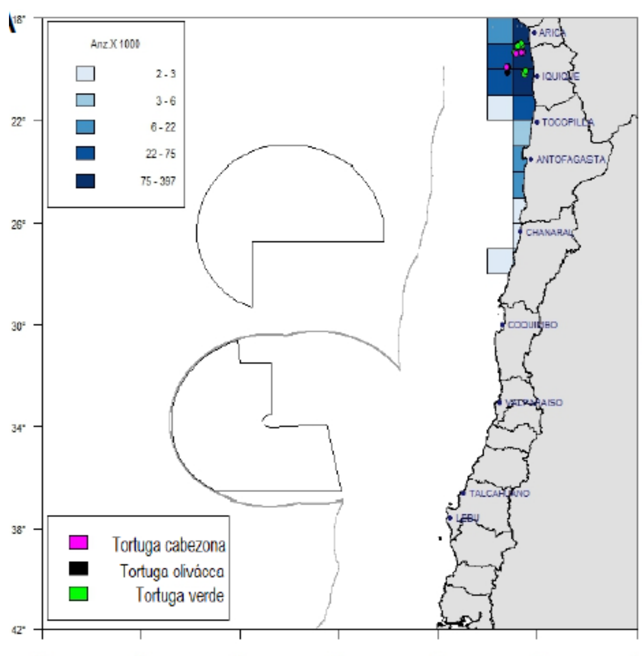


Figure 6. Spatial distribution of interaction between sea turtles (loggerhead, Olive ridley and green turtles; pink, black and green, respectively) and the artisanal longline (espinel in Spanish) fleet effort (hooks set), which operated on sharks during 2018 (Ref 104).

The foraging habitats degradation associated with coastal development and marine pollution has been an important threat to *C. mydas* population, both in the mainland and insular Chile. In northern territory, the natural presence of heavy metals together with pollution linked to mining and aquaculture infrastructure has led to high levels of these pollutants in black turtle´s tissues (Ref 4). Also, elevated levels of fecal contamination have been reported in the habitat of this species in Arica (Ref 11). During monitoring in Rapa Nui, some turtles exhibited skin lesions probably associated with marine pollution (Ref 5). Plastic pollution also constitutes a threat to this species, which is one of the most affected in Chilean coasts (Ref 93). Items found in the digestive system and feces include plastic fragments, plastic bags, remains of industrial products, bottle caps, among others (Ref 22, 53, 86, 93, 95).

C. mydas is the species with a higher number of strandings in Chile (Ref 3) reaching up 55% since 2009 and 33% of the cases during 2019 (Ref 78). The cause of death was indetermine in most cases (Ref 78). Although there are only a few records, boat strikes have been observed in Rapa Nui mainly in fishing coves where turtles feed (Ref 2). Sea lion´s attacks have been reported as a mortality cause for black turtles from Antofagasta and Arica (Ref 52, 55, 56, 81), two aggregations that have significantly declined their numbers during the last years (Ref 52, 55, 56). On the other hand, energy megaprojects constitute potential threats for foraging areas of this species in Chile due to marine pollution, increasing boat traffic, noise, offshore drilling, among others) (Andes LNG: SEA, 2016a. Res.Ex. N°65/2019; Copiaport-e: SEA, 2016b).

2.4. Conservation

C. mydas has been classified as an Endangered species by the RCE in 2015 (D.S. Nº16, 2006; MMA). Currently, there are four programs focused on the conservation of this species in Chile, which carry out monitoring, education and outreach activities:

Tortumar/Universidad Arturo Prat and Tortuga Verde NGO in Arica and Parinacota Region, Qarapara NGO in Atacama Region, and IFOP at a national level. In order to mitigate anthropogenic threats to turtle´s aggregations and their habitats, two proposals to create marine protected areas focused on *C. mydas* have been elaborated: one in La Puntilla, Arica and Parinacota Region (Acuerdo N°5/2019), and another in Bahia Salado, Atacama Region. This last proposal arose in response to the approval of an energetic megaproject that constitutes a potential threat for turtles and seagrasses (*Zostera chilensis*) (SEA 2016a; Res.Ex. N°65, 2019).

2.5. Research

Although *C. mydas* is one of the most studied species in Chile, demographic tendencies and part of its ecology (such as its diet, growth rates, local and regional movements) remain little known. Recently, the population characteristics and growth rates for *C. mydas* foraging in La Puntilla, Arica Bay (Arica and Parinacota Region) was published (Ref 84). In such a study, a population of up to 514 individuals was estimated using the mark-recapture method, demonstrating Arica Bay is the most important feeding congregation of this species in Chile. On the other hand, satellite tracking of some green turtles from this foraging ground was carried out. Most individuals remained on the same site, while one of them was monitored 4,000 km of Hawaii, reaching a trip of almost 9,000 km (Ref 75).

Health research, especially in highly polluted foraging habitats, is necessary. During the last years, studies related to genetics, morphology, and ecology have been published in scientific journals; however, there is still information about this species that has not been published.

3. RMU *Lepidochelys olivacea* Eastern Pacific Ocean (LO-EPO)

3.1. Distribution, abundance, trends

3.1.1 Nesting sites

There are not nesting sites in Chile.

3.1.2 Marine areas

The olive ridley is a cosmopolitan species with breeding sites located in tropical waters (Pritchard 1969; Marquez 1990). Chilean populations would correspond to the Eastern Pacific subpopulation (Ref 92). In Chile, this species is common to observe in oceanic and neritic areas, especially in northern and central Chile (Ref 14, 23, 35, 49, 54, 77, 92, 101, 103, 104). However, there are sighting and stranding records in the south of the country as far as Chalcas (Puerto Montt, 41º28'S, 72º57W; Ref 72) and Calbuco (41º46'S; 73º08'W; Ref 92).

3.2. Other biological data

Genetic research from bycatch data suggests olive ridley turtles from Chile have their natal origin in Mexican and Central American beaches. However, it is not ruled out the western Pacific as a place of origin (Ref 104).

Previous findings showed this species feed on brown algae (Ref 49). Stable isotopes analyses from fisheries data suggest the preys selected by olive ridley turtles would be similar to those consumed by loggerheads in Chile; thus, both species would occupy close trophic levels (Ref 101).

3.3. Threats

3.3.1 Nesting sites

There are not nesting sites in Chile.

3.3.2. Marine areas

This species is mainly affected by the artisanal longline fishery targeting sharks and mahi mahi (Figure 6) (*Coryphaena hippurus*) (Ref 101, 103). Nevertheless, there are bycatch records in artisanal gillnets (Figure 1) (Ref 101) and also records associated with the artisanal and industrial surface longline fleet (no longer used in Chile since 2018, Ref 14, 17).

Plastic pollution has been identified as a significant threat for olive ridley turtles in Chilean waters (Ref 93). Items found in the digestive systems and feces include plastic remains, plastic bags, and packaging bands (Ref 22, 23, Miguel Mansilla pers. comm).

In 2019 using histological and molecular diagnosis the first case of fibropapillomatosis in an olive ridley turtle from Chile and also, from the southeastern Pacific region was reported (Ref 7). Although other cases have not been reported in Chile, this disease is present in Chilean waters and it is considered as a potential cause of stranding or death in turtles entering rehabilitation centers.

During 2019, 65% of the stranding records corresponded to olive ridley turtles. Most of the stranding events occurred during summer (January to March) in northern and central Chile (Ref 78).

3.4. Conservation

L. olivacea has been classified as Vulnerable species by the RCE in 2016 (D.S. Nº 06, 2017; MMA). Currently, the IFOP is evaluating different types of fisheries affecting olive ridley populations to propose and promote mitigation measures at a national level.

3.5. Research

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 This information will be incorporated into the National Action Plan for sea turtle conservation in Chile.

Most of the published studies of this species have reported epibiont load (Ref 23, 46, 70). Ecological research is crucial to understand the importance of Chilean waters for olive ridley turtles and to protect its populations and habitats.

4. RMU *Caretta caretta* Eastern Pacific Ocean (CC-EPO)

4.1. Distribution, abundance, trends

4.1.1 Nesting sites

There are not nesting sites in Chile.

4.1.2. Marine areas

C. caretta has a circumglobal distribution. Chilean populations would be part of the South Pacific subpopulation (Ref 90), which breeds in eastern Australia and New Caledonia (Limpus 2008). There are records of this species from northern Chile as far as Bio Bio Region (38°10'59'', Ref 21, 35, 77). Also, there are some records of *C. caretta* from insular Chile (Easter Island, Ref 90, 93, 96).

4.2. Other biological data

Genetic research indicates *C. carett*a individuals from Chile have haplotypes shared with Australia and New Caledonia (Ref 103, 104). Stable isotopes analyses from fisheries data suggest this species occupies a trophic level similar to *L. olivacea* in Chilean waters (Ref 101).

4.3. Threats

4.3.1 Nesting sites

There are not nesting sites in Chile.

4.3.2. Marine areas

This species is mainly affected by the artisanal longline targeting shark and mahi mahi (Figure 5 and 6) (*Coryphaena hippurus*) and gillnets to a lesser extent (Ref 101, 103, 104). Until 2018, there are records of bycatch associated with artisanal and industrial swordfish longline fleet (Ref 17, 40). Recently, an entanglement loggerhead turtle was reported on Easter Island associated with a ghost net (Ref 93).

4.4. Conservation

This species has been classified as Critically Endangered by the RCE in 2016 (D.S. Nº 06, 2017; MMA). Currently, the IFOP is evaluating different types of fisheries affecting loggerhead populations to propose and promote mitigation measures at a national level.

4.5. Research

Ecological studies are necessary to implement management and protection measures, especially in national fisheries.

5. RMU *Eretmochelys imbricata* Eastern Pacific Ocean (EI-EPO)

5.1. Distribution, abundance, trends

5.1.1 Nesting sites

There are not nesting sites in Chile.

5.1.2. Marine areas

The hawksbill turtle has a circumglobal distribution; however, this species is mainly restricted to tropical and subtropical waters. In the Eastern Pacific region, the hawksbill turtle is distributed between Baja California (Mexico) to Peru (Quiñones et al. 2011) and recently was described in Easter island (Ref 1, 91). The origin of this species in Chile remains unknown.

5.2. Threats

5.2.1 Nesting sites

There are not nesting sites in Chile.

5.3.2. Marine areas

The record of *E. imbricata* on Easter island was based on two juvenile individuals found on the island; one of them was found floating and derived for veterinary assisting. During the rehabilitation process, plastic remains were found in its feces. Some weeks after, this turtle was found dead with signs of kidney failure and intestine obstruction (Ref 1). Despite there are no more cases of hawksbill turtles affected by marine pollution; this could be a significant threat for this species considering its benthic behavior associated with coral reefs, and the negative impact on the island of the South Pacific Subtropical Gyre related with garbage accumulation (Ref 93).

5.4. Conservation

This species has been classified as Critically Endangered by the RCE in 2017 (D.S. Nº 06, 2017; MMA). No data exist on fisheries affecting this species in Chilean waters.

5.5. Research

There are no published studies focused on *E. imbricata* in Chile. Ecological research (including genetics, and diet, among others) and local waste management are crucial to protect hawksbill turtle populations and habitat on Easter island.

Table 1. Main biology and conservation aspects of sea turtles in Chile.

	Cm	Ref #	**Dc**	Ref #	**Lo**	Ref #	**Cc**	Ref #	**Ei**	Ref #
Occurrence										
Pelagic foraging grounds	Y	13, 14, 15, 16, 17, 18, 21, 22, 26, 35, 39, 40, 48, 58, 61, 62, 63, 64, 65, 72, 77, 80, 100, 101, 102	Y	13, 14, 16, 17, 18, 22, 35, 39, 40, 48, 60, 61, 62, 63, 64, 65, 72, 77, 89, 100, 101, 102, 103, 104	Y	13, 14, 16, 17, 22, 35, 39, 40, 48, 60, 61, 62, 63, 64, 65, 72, 77, 100, 101, 102, 103, 104	Y	13, 14, 16, 17, 18, 22, 35, 38, 39, 40, 48, 61, 62, 63, 64, 65, 72, 77, 90, 100, 101, 102, 103, 104	N	
Benthic foraging grounds	Both	2, 4, 5, 6, 8, 10, 11, 19, 25, 27, 36, 37, 42, 50, 51, 52, 54, 56, 59, 61, 65, 68, 69, 73, 75, 76, 77, 80, 81, 83, 85, 98	Both	2, 27, 61, 65	Both	2, 11, 27, 61, 65	Both	2, 27, 61, 65	Y	1, 2, 5, 8
Published studies										
Growth rates	Y	80, 81	N		N		N		N	
Genetics	Y	4, 10, 36, 37, 39, 40, 42, 44, 45, 77, 98, 100, 104	Y	36, 39, 40, 77, 103, 104	Y	36, 39, 40, 100, 103, 104	Y	36, 38, 39, 40, 103, 104	N	
Stocks defined by genetic markers	Y	4, 10, 36, 39, 42, 54, 77, 98	Y	36, 39, 45, 66, 103, 104	Y	36, 103, 104	Y	36, 39, 45, 103, 104	N	
Remote tracking (satellite or other)	Y	51, 61, 75, 76	N		N		N		N	
Survival rates	N		N		N		N		N	
Population dynamics	Y	73, 101	Y	101	Y	101	Y	101	N	
Foraging ecology (diet or isotopes)	Y	30, 47, 59, 73, 79, 85, 94, 100, 101, 103	Y	77, 101, 103	Y	49, 100, 101	Y	49, 78, 101, 103	N	
Capture-Mark-Recapture	Y	4, 51, 54, 61, 80, 81, 100, 103, 104	Y	16, 22, 28, 100, 103, 104	Y	22, 100, 103, 104	Y	100, 103, 104	N	
Threats										
Bycatch: presence of small scale / artisanal fisheries?	Y (PLL, SN,DN,OTH: SN(Purse seine))	2, 9, 22, 24, 27, 28, 72, 77	Y (PLL, SN,DN,OTH: SN(Purse seine))	14, 16, 17, 18, 22, 27, 48, 61, 65, 77, 100, 101, 102, 103, 104	Y (PLL, SN,DN,OTH: SN(Purse seine))	14, 16, 17, 18, 22, 48, 61, 65, 100, 101, 102, 103, 104	Y (PLL, SN,DN,OTH: SN(Purse seine))	14, 16, 17, 18, 48, 61, 65, 100, 101, 102, 103, 104	N	

Bycatch: presence of industrial fisheries?	Y (PLL, SN (Purse seine))	13, 14, 16, 17, 18, 22, 27, 38, 39, 40, 48, 61, 62, 63, 64, 65, 102, 104	Y (PLL, SN (Purse seine))	13, 14, 16, 17, 18, 22, 27, 36, 38, 39, 40, 41, 48, 61, 62, 63, 64, 65, 96, 101, 102, 103, 104	Y (PLL, SN (Purse seine))	13, 14, 16, 17, 18, 22, 38, 39, 40, 61, 62, 63, 64, 65, 102, 103, 104	Y (PLL, SN (Purse seine))	13, 14, 16, 17, 18, 22, 38, 39, 40, 48, 61, 62, 63, 64, 65, 102, 103, 104	N	
Bycatch: quantified?	Y	13, 14, 16, 17, 18, 22, 39, 40, 48, 61, 62, 63, 64, 65, 100, 101, 102, 103, 104	Y	13, 14, 16, 17, 18, 22, 39, 40, 48, 61, 62, 63, 64, 65, 100, 101, 102, 103, 104	Y	13, 14, 16, 17, 18, 22, 39, 40, 48, 61, 62, 63, 64, 65, 100, 101, 102, 103, 104	Y	13, 14, 16, 17, 18, 22, 39, 40, 61, 62, 63, 64, 65, 100, 101, 102, 103, 104	N	
Take. Intentional killing or exploitation of turtles	Y	2, 9, 22, 24, 27, 28, 35, 72, 77	N		Y	22, 24	Y	27, 35, 72	N	
Coastal Development. Boat strikes	Y	8	Y	86	Y	22, 24, 86	N		N	
Pollution (debris, chemical)	Y	2, 4, 8, 11, 22, 24, 27, 53, 77, 86, 93	Y	22, 86	Y	11, 24, 86	N		Y	1
Pathogens	N		N		Y	7	N		N	
Climate change	N		N		N		N		N	
Foraging habitat degradation	Y	2, 3, 4, 8, 12, 31, 97	Y	3	Y	3	Y	3	y	1
Depredation	Y	24, 27, 52, 54, 55, 56, 61, 77, 81, 82, 86	Y	67, 86	Y	24, 61, 86	Y	61	N	
Epibionts	Y	22, 27, 46, 68, 82, 83	Y	22	Y	22, 23, 27, 46, 49, 70	Y	22	N	
Debilitated Turtle Syndrome (DTS)/Buoyancy disorder	Y	46, 82, 86, 95	Y	86	Y	46, 57, 86	Y	46	N	
Strandings	Y	3, 28, 52, 65, 71, 74, 77, 78	Y	3, 65, 77, 78	Y	3, 65, 71, 77, 78	Y	3, 65, 77, 78	Y	1, 3, 78
Long-term projects										
Monitoring at foraging sites	Y	2, 4, 5, 6, 50, 51, 56, 61, 65, 75, 76, 80, 81, 98	Y	50, 65, 103, 104	Y	50, 65	Y	65, 103, 104	N	
Conservation										
Protection under national law	Y	14, 20, 22, 27, 29, 32, 33, 61, 77, 80, 87, 88, 99, 103, 104	Y	14, 20, 22, 27, 29, 32, 33, 61, 77, 88, 89, 99, 104	Y	14, 20, 22, 27, 29, 32, 34, 61, 77, 88, 92, 99, 104	Y	14, 20, 22, 27, 29, 32, 34, 61, 77, 88, 90, 99, 104	Y	29, 34, 88, 91, 99, 101
Long-term conservation projects (number)	3	4, 27, 51, 59, 61, 75, 76, 80, 81, 82, 100, 101	1	27, 61, 100, 101	1	27, 100, 101	1	61, 100, 101	N	
Head-starting	N		N		N		N		N	

By-catch: fishing gear modifications (eg, TED, circle hooks)	Y (PLL)	38, 39, 40, 101, 104	Y (PLL)	38, 39, 40, 43,66, 101, 104	Y (PLL)	38, 39, 40, 101, 103, 104	Y (PLL)	38, 39, 40, 101, 103, 104	Y	101
By-catch: onboard best practices	Y	13, 16, 17, 61, 101, 102, 104	Y	13, 16, 17, 61, 101, 102, 104	Y	13, 16, 17, 61, 101, 102, 103, 104	Y	13, 16, 17, 101, 102, 103, 104	Y	101
By-catch: spatio-temporal closures/reduction	N		N		N		N		N	
Research	Y	Bycatch, foraging ecology, genetics, adaptation, associated bacteria analysis, epibionts	Y	Foraging ecology, genetics, bycatch	Y	Foraging ecology, genetics, bycatch	Y	Foraging ecology, genetics, bycatch	N	

Table 2: International conventions protecting sea turtles signed by Chile (based on Ref 21).

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 CITES; implemention of appropriate fishing practices and gear technology to reduce bycatch of turtles in all relevant fisheries; use of Turtle Excluder Devices 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 pollution; 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 Cons. 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 Reg. Coop. 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. Institutions and organizations involved in sea turtle conservation, management and research.

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)
	Pacífico Laud NGO	Fisheries research, sea turtle monitoring and bycatch reduction	Regional-Southern Chile

REFERENCES

1. Álvarez-Varas, R., Flores, M., García, M., Demangel, D. & N. Sallaberry-Pincheira (2015a) First confirm report of Hawksbill Sea Turtle Eretmochelys imbricata in nearshore waters of Easter Island (Rapa Nui). Revista de Biología Marina y Oceanografía 50(3):597-602.
2. Álvarez-Varas, R., Fuentes-Hurtado, M, Stowhas P. & R. Petitpas (2015b) Conservation Research Needs of Easter Island (Rapa Nui) Marine Turtles. Chelonian Conservation and Biology 14(2):184-192.
3. Álvarez-Varas, R., Berzins, R., Bilo, K., Chevalier, J., Chevallier, D., De Thoisy, B., Fallabrino, A., García Cruz, M., Kelez, S., Lopez-Mendilaharsu, M., Marcovaldi, M.A. Mast, R.B., Medrano, C., Miranda, C., Nalovic, M.A., Prosdocimi, L., Rguez-Barón, J.M., Santos, A., Soares, L., Thome, J., Vallejo, F. & G. Vélez-Rubio (2016) Sea turtles of South America. SWOT Report Vol. XI. 52 pp.
4. Álvarez-Varas, R., Contardo, J., Heidemeyer, M., Forero-Rozo, L., Brito, B., Cortés, V., Brain, M.J., Pereira, S. & J.A. Vianna (2017a) Ecology, health and genetic characterization of the southernmost green turtle (Chelonia mydas) aggregation in the Eastern Pacific: implications for local conservation strategies. Latin American Journal of Aquatic Research 45(3):540-554.
5. Álvarez-Varas, R., González-Johannes, C. & M. García-Baral (2017b) Rapa Nui: Oasis de Tortugas Marinas. Moe Varua: 8 diciembre 2017. http://www.moevarua.com/rapa-nui-oasis-de-tortugas/
6. Álvarez-Varas, R. & González-Johannes, R. (2018). Tortugas Marinas. In: I ROTO TE MOANA O RAPA NUI Biodiversidad Marina de Rapa Nui (Eds). S. Narváez & C. Gaymer. Universidad Católica del Norte, Facultad Ciencias del Mar, Núcleo Milenio de Ecología y Manejo Sustentable de Islas Oceánicas (ESMOI) I.S.B.N. 978-956-287-419-9.
7. Álvarez-Varas, R., Cárdenas, C., Cucalón, R., Del Río, J., Cifuentes, F., Ulloa, M., Briceño, C. & Cárdenas, W.B. (2019a). First report of fibropapillomatosis in an olive ridley turtle *Lepidochelys olivacea* from the southeastern Pacific. Diseases of Aquatic Organisms 135: 43-48.
8. Álvarez-Varas, R. & González-Johannes. (2019b) Monitoreo de Tortugas Marinas en Rapa Nui. Moe Varua: Número 132, Pags. 6-9. Febrero 2019.
9. Álvarez-Varas, R., Barrios-Garrido, H., Skamiotis-Gómez, I. & Petitpas, R. (2020a). Cultural role of sea turtles on Rapa Nui (Easter Island): Spatial and temporal contrast in the Pacific island region. Island Studies Journal. Island Studies Journal 15(1): 253-270.
10. Álvarez-Varas, R., Heidemeyer, M., Riginos, C. Benítez, H.A., Reséndiz, E., Lara-Uc, M., Godoy D.A., Muñoz-Pérez, J.P., Alarcón-Ruales, D.E., Vélez-Rubio, G.M., Fallabrino, A., Piovano, S., Alfaro-Shigueto, J., Ortiz-Alvarez, C., Mangel, J.C., Esquerré, D., Zárate, P., Medrano, C., León Miranda, F., Guerrero, F., Vianna J.A., & Véliz, D. (2020b). Integrating morphological and genetic data at different spatial scales in a cosmopolitan marine turtle species: challenges for management and conservation. Zoological Journal of the Linnean Society. Zoological Journal of the Linnean Society zlaa066: 1-20.

11. Aramayo, O., De la Barrera, F. & C. Guerra-Correa (2006) Elaboración de Plan de Manejo de los Sitios Prioritarios de la Estrategia Regional de Biodiversidad: Península de Mejillones y Sector Costero de Paposo, II Región de Antofagasta. Informe Final. Co-participación de Centro Regional de Estudios y Educación Ambiental CREA-UA. Vicerrectoría Académica, Universidad de Antofagasta. 245 pp.

12. Astudillo, M., Hernández, T., Salinas, P., Sielfeld, W., Santander, E. & J. Jaque (2017) Echerichia coli como indicador de contaminación fecal en el hábitat de Chelonia mydas en Bahía Chinchoro, Arica, Chile. VI Simposio regional sobre tortugas marinas en el Pacífico Sur Oriental. Arica, Chile. p.70.

13. Azócar, J. & L. Miranda (2008) Contribución de los Observadores Científicos a bordo de la flota palangrera industrial en la conservación de tortugas marinas. II Simposio de tortugas marinas en el Pacífico Sur Oriental. Lima-Perú.

14. Azócar, J., Olguín A. & P. Gálvez (2011) Consultoría Nacional "Diagnostico sobre tortugas marinas en Chile". CPPS. Instituto de Fomento Pesquero 2011. 180 pp.

15. Bahamondes, N. (1972) Límite austral de *Chelonia mydas agassizii* en el Pacífico suroriental. Noticiario Mensual, Museo Nacional de Historia Natural Chile. 189:9-10.

16. Barría, P., Azocar, J., González, A., Bernal, C., Mora, S., Cerna, F., Devia, C. y H. Miranda. (2014). Informe Final. Convenio I: Asesoría Integral para la Pesca y la Acuicultura 2014. Programa de Seguimiento de Recursos Altamente Migratorios.

17. Barría, P., Azocar, J., González, A., Devia, D., Bernal, C., Mora, S., Cerna F., & H. Miranda (2015) Convenio Desempeño 2014/Proyecto: Programa Seguimiento de Recursos Altamente Migratorios 2014. IFOP - Subsecretaría de Economía y Empresas de Menor Tamaño: 160 pp.

18. Barría, P., Azocar, J., González, A., Devia, D., Mora, S., Cerna, F., Cid, L., Miranda, H., Zárate, P. & A. Urzúa (2016) Convenio de desempeño 2015/Proyecto: Programa de seguimiento recursos altamente migratorios 2015. Informe final. IFOP - Subsecretaría de Economía y Empresas de Menor Tamaño. 716 pp.

19. Bolados, P., Guerra-Correa, C., Guerra, C. & A. Silva (2007) Estudio poblacional de la congregación de tortuga verde, Chelonia mydas (Linnaeus, 1758), presente en Bahía Mejillones del Sur, Antofagasta-Chile. VII Simposio sobre medio ambiente: estado actual y perspectivas de la investigación y conservación de las tortugas marinas en las costas del Pacífico sur oriental. Antofagasta, Chile. p. 18.

20. Brito, J. L. (1995) New hunting regulations in Chile protect sea turtles for the first time. Marine Turtle Newsletter, 1995(68):20–22.

21. Brito, J. (1997) The marine turtle situation in Chile. In: Epperly, S. and Braun, J. (Eds.). Proceedings of the Seventeenth Annual Sea Turtle Symposium. Miami, FL: U.S. Department of Commerce NOAANMFS Southeast Fisheries Science Center, 12 pp.

22. Brito, J. L. (2001) Informe preliminar de tortugas marinas en Chile: su situación actual. Taller nacional de trabajo para definir las líneas de acción prioritarias de un programa para la conservación de las tortugas marinas. Valparaíso, Chile. 95 pp.
23. Brito, J. L. (2007) Segundo reporte de asociación entre Planes cyaneus (Decapoda: Grapsidae) y tortuga olivácea Lepidochelys olivacea en la zona central de Chile. VII Simposio sobre medio ambiente: estado actual y perspectivas de la investigación y conservación de las tortugas marinas en las costas del Pacífico Sur Oriental. Antofagasta Chile. p. 44.
24. Brito, C., Brito, J.L., Zúñiga, M., Campos, M. & S. Toro (2007) Tortugas marinas en el centro de rescate y rehabilitación de fauna silvestre del museo de San Antonio. VII Simposio sobre medio ambiente: estado actual y perspectivas de la investigación y conservación de las tortugas marinas en las costas del Pacífico Sur Oriental. Antofagasta Chile. p. 45.
25. Brito, J. L., Domínguez, G., Marambio, M. & P. Gysel (2007) La necesidad de proteger a las tortugas marinas de Chascos, Bahía Salado, Región de Atacama, Chile. Estado actual y perspectivas de la investigación y conservación de las tortugas marinas en las costas del Pacífico Sur Oriental. VII Simposio sobre Medio Ambiente. Antofagasta, Chile. p. 20.
26. Cáceres, B., Lobo, A., Scholfield, D., Arcos, F., García, N., Stom, J. & J. Acevedo (2018) New Record of Black Turtle Chelonia mydas agassizii in High Latitudes of Eastern South Pacific Ocean. Journal of Life Sciences. 12. 10.17265/1934-7391/2018.03.0
27. Canales-Cerro, C. A. & R. E. Álvarez-Varas (2015) History, Science and Conservation of Sea Turtles in Chile. In: Successful Conservation Strategies for Sea Turtles: Achievements and Challenges (Eds). Ma. Mónica Lara-Uc, Juan M. Rguez-Baron, & Rafael Riosmena-Rodriguez. Nova Science Publishers, Inc. New York, USA. pp. 1-22.
28. Chandler, M. (1991) New records of marine turtles in Chile. Marine Turtle Newsletter 52: 8-11.
29. CONAMA (2008) Biodiversidad de Chile: Patrimonio y desafíos. Ocho libros editores (Santiago de Chile) 2da edición, 598-608.
30. Contardo, J., Jáuregui, M., Heidemeyer, M. & R. Álvarez-Varas (2016) First approach of black turtle (Chelonia mydas) trophic ecology in Bahía Salado, northern Chile, using stable isotope analysis. Proceedings of the Thirty-Six Annual Symposium on Sea Turtle Biology and Conservation. Lima, Peru, March 2016.
31. Cortés, E., Guerra-Correa, C. & B. Helena-Soto (2007) Evaluación de la calidad de hábitat en congregación de tortugas marinas, mediante el uso de sensores biológicos (macroalgas marinas). VII Simposio sobre medio ambiente: estado actual y perspectivas de la investigación y conservación de las tortugas marinas en las costas del Pacífico sur oriental. Antofagasta, Chile. p. 42.
32. Decreto Exento 225 de 1995 Establece veda para los recursos hidrobiológicos que indica. Ministerio de Economía, de Fomento y Reconstrucción. Diario Oficial Nº 35314 del 11 de Noviembre de 1995.

33. Decreto Supremo (D.S.) N°16 (2016) Ministerio del Medio Ambiente (MMA). Aprueba y oficializa clasificación de especies según estado de conservación, duodécimo proceso. Diario Oficial de la República de Chile, 3 de Junio de 2016.
34. Decreto Supremo (D.S.) N° 06 (2017) Ministerio del Medio Ambiente (MMA). Aprueba y oficializa clasificación de especies según estado de conservación, décimo tercer proceso. Diario Oficial de la República de Chile.
35. Donoso-Barros, R. (1966) Reptiles de Chile. Ediciones de la Universidad de Chile, 458 pp.
36. Donoso, M., Dutton, P., Serra, R. & J. L., Brito-Montero (1999) Sea turtles found in waters off Chile. In: Kalb, H. & Wibbels, T (Eds.). Nineteenth Annual Symposium on Sea Turtle Conservation and Biology. South Padre Island, TX; US. Departament of Commerce NOAA/NMFS Southeast Fisheries Science Center. p. 219.
37. Donoso, M. y P. Dutton (2002) Forage area identified for green turtles in Northern Chile. In: Mosier, A., Foley, A. and B. Brost (comp.). Proceedings of the Twentieth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-477:274.
38. Donoso, M. & P. Dutton (2007) Distribución y abundancia relativa de tortugas marinas capturadas incidentalmente por la flota palangrera industrial chilena de pez espada en el Pacifico Sur Oriental. VII Simposio sobre medio ambiente: estado actual y perspectivas de la investigación y conservación de las tortugas marinas en las costas del Pacífico Sur Oriental. Antofagasta, Chile. p. 16.
39. Donoso, M. & P. Dutton. (2008) Numbers, distribution and stock origin of sea turtles caught incidentally in the Chilean longline fishery for swordfish, 2001-2002. In: L. Belskis (Ed.). Proceedings of the Twenty-Fourth Annual Symposium on Sea Turtle Biology and Conservation. 22 to 29 February 2004. San José, Costa Rica. NOAA Technical Memorandum NMFS-SEFSC- 567.
40. Donoso, M., & P. Dutton (2010) Sea turtle bycatch in the Chilean pelagic longline fishery in the southeastern Pacific: Opportunities for conservation. Biological Conservation 143:2672-2684.
41. Donoso, M. (2016a) Characterzation of fishing gear that has an impact on the capture of leatherbacks turtles in the artisanal fisheries of Chile. 36th Annual Symposium on Sea Turtle Biology and Conservation, 29 February-4th March 2016, Lima, Peru.
42. Donoso, M., Dutton, P. & E. LaCasella (2016) Nesting population origin of a Green turtle foraging aggregation in northern Chile determined from mtDNA analysis: drawing new boundaries to management units in the Southeastern Pacific. 36th Annual Symposium on Sea Turtle Biology and Conservation, 29 February-4th March 2016, Lima, Peru.
43. Donoso, M., Dutton, P., Wang, J. & C. Fahy (2016) Marine mammal and sea turtle bycatch reduction in the drift gillnet fishery in Chile. 36th Annual Symposium on Sea Turtle Biology and Conservation, 29 February-4th March 2016, Lima, Peru.
44. Dutton, P. (2003) Molecular ecology of Chelonia mydas in the Eastern Pacific Ocean. Proceedings of the twenty-second annual symposium on sea turtle biology and conservation, 4-7 April 2002.

45. Dutton, P., LaCasella, E., Alfaro-Shigueto, J., Campos, N., Donoso, M. & J. Mangel (2019) Stock origin of leatherback, loggerhead and green turtles foraging in the southeastern pacific: insights into their trans-oceanic connectivity. 36th Annual Symposium on Sea Turtle Biology and Conservation, 29 February-4th March 2016, Lima, Peru.

46. Fernández, I., Retamal, M.A., Mansilla, M., Yáñez, F., Campos, V., Smith, C., Puentes, G., Valenzuela, A. & H. González (2015) Analysis of epibiont data in relation with the Debilitated Turtle Syndrome of sea turtles in Chelonia mydas and *Lepidochelys olivacea* from Concepción coast, Chile. Latin American Journal of Aquatic Research 43(5):1024-1029.

47. Formas, C. R. (1976) Encuentro de Chelonia mydas agassizi (Testudinata; Chelonidae) en la costa de Valdivia. Boletín de la Sociedad de Biología de Concepción 5:213-214.

48. Frazier, J. G. & J. L. Brito (1990) Incidental capture of marine turtle by the swordfish fishery at San Antonio, Chile. Marine Turtle Newsletter 49:8-13.

49. Gonzalez, A., Miranda, L. & J. C. Ortiz (2003) First record of a gravid marine turtle from south central Chilean coast. Chelonian Conservation and Biology. 4(3):716-717.

50. González, C. & R. Álvarez-Varas (2017) Aislados en el Pacífico: la importancia de Hanga Roa como hábitat de tortugas marinas en el Pacífico Sur Oriental. VI Simposio regional sobre tortugas marinas en el Pacífico Sur Oriental. Arica, Chile. p. 69.

51. Guerra-Castro, C. Guerra-Correa, C., Bolados, P. & A. Silva (2007) Congregación de tortugas marinas Chelonia mydas y la utilización de una descarga térmica de agua para la termoregulación, en el litoral de la bahía de Mejillones del Sur, Mejillones-Chile. VII Simposio sobre medio ambiente: estado actual y perspectivas de la investigación y conservación de las tortugas marinas en las costas del Pacífico Sur Oriental. Antofagasta, Chile. p. 23.

52. Guerra-Correa, C., Guerra-Castro, C., Silva-Marín, A. & P. Bolados-Díaz (2007a) Lobo marino común Otaria flavescens depredando sobre Tortuga verde Chelonia mydas: Agresión conductual de aparición repentina. VII Simposio sobre medio ambiente: estado actual y perspectivas de la investigación y conservación de las tortugas marinas en las costas del Pacífico Sur Oriental. Antofagasta, Chile. p. 25.

53. Guerra-Correa, C., Valenzuela, A., Retamal, LM. & A. Malinarich (2007b) Influencia de los desechos plásticos en la sobrevivencia de tortugas: el caso de Chelonia mydas en Antofagasta. VII Simposio sobre medio ambiente: estado actual y perspectivas de la investigación y conservación de las tortugas marinas en las costas del Pacífico Sur Oriental. Antofagasta, Chile. p. 46.

54. Guerra-Correa, C., Guerra-Castro, C., Silva, A., Malinarich, A. Retamal, L. M., Morales, S. & C. Alihuanca (2008) Ampliación de áreas de congregación y alimentación de tortuga verde y noticias sobre el estado de madurez sexual de ejemplares de L. olivacea en el norte de Chile. II Simposio de tortugas marinas en el Pacífico Sur Oriental. Lima-Perú. p. 45.

55. Guerra-Correa, C., Silva, A., Guerra-Castro, C. & A. Malinarich (2008) Efecto disruptivo local del balance natural del ciclo de las tortugas marinas por depredación oportunista del lobo marino Otaria flavescens en Bahía Mejillones del Sur: potencial riesgo de la ampliación de la anomalía. II Simposio de tortugas marinas en el Pacífico Sur Oriental. Lima-Perú. p. 48.
56. Guerra-Correa, C., Guerra-Castro, C. & J. Páez-Godoy (2017) Presencia de tortugas marinas en aguas de la Península de Mejillones (Chile, 23° Lat Sur) posterior a la mortalidad causada por lobos marinos Otaria flavescens sobre Tortuga verde Chelonia mydas. VI Simposio regional sobre tortugas marinas en el Pacífico Sur Oriental. Arica, Chile. p.42.
57. Guerra-Correa, C. & A. Valenzuela (2017) Posibles causas de mortalidad de tortugas marinas mediante observaciones y análisis veterinario post-mortem. VI Simposio regional sobre tortugas marinas en el Pacífico Sur Oriental. Arica, Chile. p. 43.
58. Guzmán, L. & I. Campodónico (1973) Presencia de *Chelonia mydas agassizi* bocourt en Magallanes. ANS. INST. PAT., Punta Arenas (Chile) 4(1-3): 339-341.
59. Harrod, C., Salinas, P., Docmac, F., Gonzalez, K. & W. Sieldfeld (2017) Análisis de isótopos estables revelan distintas estrategias de forrajeo y la importancia de las algas rojas en la dieta de Chelonia mydas en el norte de Chile. VI Simposio regional sobre tortugas marinas en el Pacífico Sur Oriental, Arica, Chile. p. 36.
60. Ibarra-Vidal, H. & J.C. Ortiz (1990) Nuevos registros y ampliación de la distribución geográfica de algunas tortugas marinas en Chile. Bol. Soc. Biol. Concepción, Chile 61:149-151.
61. Interamerican Convention for the Protection and Conservation of Sea Turtle (IAC) (2011) Annual report Chile 2011. 25 pp.
62. Interamerican Convention for the Protection and Conservation of Sea Turtle (IAC) (2012) Annual report Chile 2012. 20 pp.
63. Interamerican Convention for the Protection and Conservation of Sea Turtle (IAC) (2013) Annual report Chile 2013. 18 pp.
64. Interamerican convention for the protection and conservation of sea turtle (IAC) (2014) Annual report Chile 2014. 16 pp.
65. Interamerican convention for the protection and conservation of sea turtle (IAC) (2015) Annual report Chile 2015. 26 pp.
66. Laúd OPO Network (2020) Enhanced, coordinated conservation efforts required to avoid extintion of critically endangered Eastern Pacific leatherback turtles. Scientific reports, Nature research 10:4772. DOI: 10.1038/s41598-020-60581-7
67. López, S., Meléndez, R. & P. Barría (2010) Preliminary diet analysis of the blue shark Prionace glauca in the eastern South Pacific. Revista de Biología Marina y Oceanografía. 45, S1:745-749.
68. López, C., Marambio, M. & J. L. Brito (2007) Primer registro de epibiontes de la población de *Chelonia mydas* (Linnaeus, 1758) residente en la III Región de Chile. VII Simposio sobre medio

ambiente: estado actual y perspectivas de la investigación y conservación de las tortugas marinas en las costas del Pacífico sur oriental. Antofagasta, Chile. p. 40.

69. Marambio, C., López, C. & J. L Brito (2007) Nuevo registro de una población de Chelonia mydas residente en un área de alimentación en la costa de la Región de Atacama, norte de chile. VII Simposio sobre medio ambiente: estado actual y perspectivas de la investigación y conservación de las tortugas marinas en las costas del Pacífico sur oriental. Antofagasta, Chile. p. 39.

70. Miranda, L. & R. A. Moreno (2002) Epibiontes de Lepidochelys olivacea (Eschscholtz, 1829) (Reptilia: Testudinata: Cheloniidae) en la región centro sur de Chile. Revista de Biología Marina y Oceanografía 37(2):145-146.

71. Miranda, L. & J. C. Ortiz (2003) Sea turtles strandings in Chile (VII Region). Proceedings of the Twenty-second Annual Symposium on Sea Turtle Biology and Conservation, 4-7 April 2002. p. 268.

72. Ortiz, J.C. & R. Moreno (2008) Diversidad y biología de tortugas marinas.:269-299 En: Vidal, M.A. & A. Labra (eds.) Science Verlag Ediciones, Santiago, Chile.593pp.

73. Petit, I.J., González, C.F., Gusmao, J.B, Álvarez-Varas, R. & Hinojosa, I. (2020). Resting dynamics and diel activity of the green turtle (Chelonia mydas) in Rapa Nui, Chile. Chelonian Conservation and Biology. Chelonia Conservation and Biology 19(1): 124-132.

74. Salinas, P. & W. Sielfeld (2007) Registros de cadáveres de tortuga negra Chelonia mydas agassizii (Bocourt, 1868) en Bahía Chipana (21º19´S-70º03´W) Iquique-Chile. VII Simposio sobre medio ambiente: estado actual y perspectivas de la investigación y conservación de las tortugas marinas en las costas del Pacífico sur oriental. Antofagasta, Chile. p. 21.

75. Salinas, P., Contreras, D. & W. Sielfeld (2017a) Telemetría satelital para la determinación del área de alimentación de Tortuga negra *Chelonia mydas* de La Puntilla, Arica, Chile (18°28’00’’ S – 70°18’40’’ W). VI Simposio regional sobre tortugas marinas en el Pacífico Sur Oriental. Arica, Chile. p. 50.

76. Salinas, P., Sielfeld, W., Contretras, D., Santander, E., Gallardo, J., Tobar, M., Azócar, C., Jaque, J., Pizarro, K. & M. Astudillo (2017b) Programa de conservación de tortugas marinas del norte de Chile, caso La Puntilla, Arica. VI Simposio regional sobre tortugas marinas en el Pacífico Sur Oriental. Arica, Chile. p. 49.

77. Sarmiento-Devia, R., Harrod, C. & A. Pacheco (2015) Ecology and Conservation of Sea Turtles in Chile. Chelonian Conservation and Biology 14(1): 21-33.

78. SERNAPESCA (2019) Base de datos de varamientos año 2009-2019. Unidad de Rescate, Rehabilitación y Conservación de Especies Protegidas (URCEP).

79. Seminoff, J., Campos, N., Donoso, M. Dutton, P., Heidemeyer, M., Jones, T., Kelez, S., Plouffe-Malette, M., Rodriguez-Baron, M., Sampson, L., Santos, L., Schumacher, J., Zárate, P. & B. Popp (2016) Trophic ecology of green sea turtles across the eastern pacific ocean: insights from bulk tissue and compound specific stable isotope analysis. 36th Annual Symposium on Sea Turtle Biology and Conservation, 29 February-4th March 2016, Lima, Peru.

80. Sielfeld, W., Salinas, P., Contreras, D. & M. J. Brain (2015) Ficha Técnica *Chelonia mydas*. Ministerio del Medio Ambiente. 11 pp.

81. Sielfeld, W., Salinas, P. & D. Contreras (2017a) Condición de las tortugas verdes (*Chelonia mydas*) de La Puntilla, Arica, Norte de Chile. VI Simposio regional sobre tortugas marinas en el Pacífico Sur Oriental. Arica, Chile. p. 52.

82. Sielfeld, W., Gallardo, J., Guzmán, G. & P. Salinas (2017b) Cirripedios epibiontes de tortugas negras (*Chelonia mydas*) de Arica, norte de Chile. VI Simposio regional sobre tortugas marinas en el Pacífico Sur Oriental. Arica, Chile. p. 53.

83. Sielfeld, W., Gallardo, J., Guzmán, G. & P. Salinas (2017c) Cirripedios epibiontes de tortugas negras (Chelonia mydas) de Arica, norte de Chile. VI Simposio regional sobre tortugas marinas en el Pacífico Sur Oriental. Arica, Chile. p. 53.

84. Sielfeld, W., P. Salinas, D. Contreras, M. Tobar, J. Gallardo & C. Azocar. 2019. Green turtles (Chelonia mydas) from La Puntilla-Arica only urban foraging area in Chile: Phenotipic characterization and population status. Pacific Science, 73(4): 501-514.

85. Silva, A., Guerra-Correa, C., Guerra, C. & P. Bolados (2007a) Descripción de áreas de forrajeo y su incidencia en la presencia de tortugas marinas. VII Simposio sobre medio ambiente: estado actual y perspectivas de la investigación y conservación de las tortugas marinas en las costas del Pacífico Sur Oriental. Antofagasta, Chile. p. 19.

86. Silva, A. Retamal, L. M. & C. Guerra-Correa (2007b) Registros de tortugas marinas ingresadas al centro de rescate y rehabilitación de fauna silvestre. VII Simposio sobre medio ambiente: estado actual y perspectivas de la investigación y conservación de las tortugas marinas en las costas del Pacífico Sur Oriental. Antofagasta, Chile. p. 47.

87. Soto, M. (2017) Reserva marina: avanzando en la conservación de la tortuga negra (*Chelonia mydas*) en Arica, Chile. VI Simposio regional sobre tortugas marinas en el Pacífico Sur Oriental. Arica, Chile. p. 41.

88. Tala, C. & C. Rodríguez (2007) Las tortugas marinas en el marco de la política nacional de especies amenazadas y el reglamento para clasificación de especies silvestres. VII Simposio sobre medio ambiente: estado actual y perspectivas de la investigación y conservación de las tortugas marinas en las costas del Pacífico Sur Oriental. Antofagasta, Chile p. 30.

89. Tala, C. (2015) Ficha Técnica Dermochelys coriacea. Ministerio del Medio Ambiente. 12 pp.

90. Tala, C. (2016a). Ficha Técnica *Caretta caretta*. Ministerio del Medio Ambiente. 12 pp.

91. Tala, C. (2016b) Ficha Técnica *Eretmochelys imbricata*. Ministerio del Medio Ambiente. 11 pp.

92. Tala, C. (2016c) Ficha Técnica *Lepidochelys olivacea*. Ministerio del Medio Ambiente. 13 pp.

93. Thiel, M., Luna-Jorquera, G., Álvarez-Varas, R., Gallardo, C., Hinojosa, I., Luna, N., Miranda-Urbina, D., Morales, N., Ory, N., Pacheco, A., Portflitt, M. & Zavalaga, C. (2018). Impacts of marine plastic pollution from continental coasts to subtropical gyres-Fish, seabirds and other vertebrates in the SE Pacific. Frontiers in Marine Science 5:238.

94. Troncoso, J. F. (1990) Registro de Chelonia mydas agassizi Bocourt, 1868 en el litoral de la VIII Región, Chile. Comunicaciones del Museo Regional de Concepción 2:29-30.

95. Valenzuela, A., Retamal, L.M. & C. Guerra-Correa (2008) Influencia de la temperatura y fotoperiodo en actividad metabólica y recuperación de obstrucción digestiva por plásticos en *Chelonia mydas*. II Simposio de tortugas marinas en el Pacífico Sur Oriental. Lima-Perú. p. 47.

96. Vega R. & M. Cortés (2005) Monitoreo y análisis de las operaciones de pesca conjunta del pez espada CE/Chile, informe de crucero. Instituto de Fomento Pesquero y Subsecretaría de Pesca. 44p.

97. Velasco-Charpentier, C., Muñoz-Muga, P. & H. Díaz-Oviedo (2017) Caracterización del área de alimentación más austral del Pacífico Suroriental de Chelonia mydas, con énfasis en la pradera de pasto marino Zostera chilensis. VI Simposio regional sobre tortugas marinas en el Pacífico Sur Oriental, Arica, Chile. p.38.

98. Veliz, D., Salinas, P., Sielfeld, W., Contreras, D., Azócar, C., Tobar, M. & J. Gallardo (2014) Estudio poblacional y genético de la tortuga *Chelonia mydas agassizii* (Sauria: Cheloniidae) en la Playa Chinchorro, Arica, Chile. Revista de Biología Marina y Oceanografía 49(3):589-593.

99. Zárate, P., Álvarez-Varas, R., Azócar, J., Donoso, M., Guerra, C., Ortiz, J. C., Palma, A., Ponce, F., Salinas, P., Sieldfeld, W. & M. Soto (2017a) Avances en la elaboración del “Plan de acción nacional para la protección y conservación de las tortugas marinas en Chile”. VI Simposio regional sobre tortugas marinas en el Pacífico Sur Oriental, Arica, Chile. p. 33.

100. Zárate, P., Azócar, J., Devia, D. & R. Bello (2017b) Informe de avance. Programa de Seguimiento Recursos Altamente Migratorios Año 2016. Enfoque Ecosistémico. IFOP-SUBPESCA. 55 pp.

101. Zárate, P., Azócar, J., Devia, D., Bello, R., Ferrada, S., González, M.T., López, S., Urzúa, A., Barrios, R., Canales-Aguirre, C., Friz, J., Galleguillos, R., Guzmán, F., Herrera, V., Sepúlveda, F. & J.C.Saavedra (2017c) Informe Final Convenio de Desempeño 2016. Seguimiento Pesquerías Recursos Altamente Migratorios año 2016. Enfoque ecosistémico. 413 pp.

102. Zárate, P., Azócar, J., Devia, D., Ojeda, R., Bohm, G., Montenegro, C. & R. Vega (2017d) Captura incidental de tortugas marinas en las pesquerías chilenas. VI Simposio regional sobre tortugas marinas en el Pacífico Sur Oriental, Arica, Chile. p. 32.

103. Zárate, P., Cari, I., Salinas, C., Devia, D., Bello, R., Saavedra-Nievas, J.C., González, M.T., Sepúlveda, F., Klarian, S., Fernandoy, F., Moreno, Y., Harrod, C., Araya, M., Canales-Cerro, C., Vargas, F., Cárcamo, C., Julca, J., Mora, S., Ortega, J.C., Shillinger, G., Azócar, J. & P.H.,Dutton (2018). Programa de Seguimiento Recursos Altamente Migratorios año 2017. Enfoque ecosistémico. Informe final. Valparaíso, 339 pp.

104. Zárate, P., Cari, I., Clavijo, I., Azócar, J., Saavedra, J.C., Devia, D., Salinas, C., Cifuentes, U., Klarian, S., Harrod, C., Vargas, F., Fernandoy, F., Moreno, Y., Cárcamo, C., Quintanilla, I., Curaz, S., Julca, J., Fernández, M., Benidraña, L., Hucke-Gaete, R., Viddi, F., LaCasella, E., Roden, S.,

Dutton, P., Bello, R. & D. González (2019) Informe Final. Programa de Seguimiento Recursos Altamente Migratorios Año 2018. Enfoque Ecosistémico. IFOP-SUBPESCA. 374 pp.

REFERENCES cited only in the text

Acuerdo N°5/2019. Consejo de ministros para la sustentabilidad. 24 de Enero de 2019.

Bailey, H., Benson, S.R., Shillinger, G.L., Bograd, S.J., Dutton, P.H., Eckert, S.A., Morreale, S.J., Paladino, F.V., Eguchi, T., Foley, D.G., Block, B.A., Piedra, R., Hitipeuw, C., Tapilatu, R.F., & J.R. Spotila (2012) Identification of distinct movement patterns in Pacific leatherback turtle populations influenced by ocean conditions. *Ecological applications: a publication of the Ecological Society of America, 22 3*, 735-47.

Ley N°21100 Prohíbe la entrega de bolsas plásticas de comercio en todo el territorio Nacional. Ministerio del Medio Ambiente. 03 de Agosto de 2018

Limpus, C.J. (2008) A biological review of Australian marine turtle species. 1. Loggerhead turtle, *Caretta caretta* (Linneaus). The State of Queensland. Environmental Protection Agency.

Márquez, R (1990) FAO species catalogue. Vol. 11 Sea turtles of the world. An annotated and ilustrated catalogue of sea turtle species known to date. FAO Fisheries Synopsis nº 125, Vol. 11. Rome, FAO. 81pp.

Pritchard, P. (1969) Studies of the systematics and reproductive cycles of the Genus Lepidochelys. Ph.D. dissertation, University of Florida, FL.

Quiñones, J., Zeballos, J., Quispe, S., & Delgado, L. (2011) Southernmost records of hawksbill turtles along the East Pacific coast of South America. Marine Turtle Newsletter 130:16-19.

Resolución exenta (R.Ex) N°65 (2019) Ministerio del Medio Ambiente. Notifica resolución de calificación ambiental proyecto "proyecto Andes LNG". 23 de Junio de 2019.

Seminoff, J. Allen, C., Balazs, G., Dutton, P. Eguchi, T., Haas, H., Hargrove, S., Jensen, M., Klemm, D., Lauritsen, A., MacPherson, S., Opay, P., Possardt, E., Pultz, S., Seney, E., Van Houtan, K. & R. Waples (2015) Status review of the green turtle (Chelonia mydas) under the Endangered Species Act. 10.13140/RG.2.1.3943.8884.

Servicio de Evaluación Ambiental (SEA) (2016a) Andes LNG. Recuperado de: https://seia.sea.gob.cl/expediente/ficha/fichaPrincipal.php?modo=normal&id_expediente=2131608818. Consultado 18 Junio 2020.

Servicio de Evaluación Ambiental (SEA) (2016b) Copiaport-e. Recuperado de: https://seia.sea.gob.cl/expediente/ficha/fichaPrincipal.php?modo=normal&id_expediente=2142860889. Consultado 18 Junio 2020.

Shillinger, G. L., Palacios, D. M., Bailey, H., Bograd, S. J., Swithenbank, A. M., Gaspar, P., Wallace, B. P., Spotila, J. R., Paladino, F. V., Piedra, R., Eckert, S. A., & Block, B. A. (2008). Persistent leatherback turtle migrations present opportunities for conservation. PLoS biology, 6(7), e171. https://doi.org/10.1371/journal.pbio.0060171

Wallace B.P., DiMatteo A.D., Hurley B.J., Finkbeiner E.M., Bolten A.B., Chaloupka M.Y., Hutchinson B.J., Abreu-Grobois F.A., Amorocho D.F., Bjorndal K.A., et al. (2010) Regional management units for marine turtles: A novel framework for prioritizing conservation and research across multiple scales. PLoS ONE. 2010;5:e15465. doi: 10.1371/journal.pone.00154.