



The Mediterranean
Biodiversity
Centre

Conservation of the Marine Turtles in Lebanon

Results of the 2019 monitoring of the Marine Turtles along the Lebanese coast



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Conservation of the Marine Turtles in Lebanon
Results of the 2019 monitoring of the Marine Turtles
along the Lebanese coast

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Executive summary

The annual report on monitoring and conservation of marine turtles in Lebanon presents the results of the survey done during the 2019 sea turtles nesting season. This year, the monitoring effort covered 22 km of the Lebanese sandy beaches, allowing to find new important marine turtles nesting sites.

The monitoring took place from May 2019 until September 2019. Tracks, nests and hatchlings of the loggerheads (*Caretta caretta*) and greens (*Chelonia mydas*) turtles were recorded along the surveyed coast from the south to the north of the Lebanese sandy beaches. The survey allows to confirm the presence of five important marine turtle nesting sites along the Lebanese coast: the beaches of the two Marine Reserve of Tyre (TCNR) and Abbasiyeh and the beaches of Al-Addousiyeh and Al-Mansouri in the south and the Marine Reserve of the Palm Island (PINR) in the north.

A total of 77 nests were recorded in all the surveyed beaches, of which the majority are from the south of Lebanon with 55 nests representing 71%. Loggerheads turtles were the most abundant nesting species (74 nests), while only 3 nests of the green turtles were recorded. Subsequently, a total of 2561 loggerheads and 279 greens hatchlings turtles were successfully released from all the surveyed sites.

From a conservation point of view, this large survey fulfilling the scarcity of data on the distribution of marine turtles nests along the Lebanese coast for future monitoring of their evolution.

Unfortunately, marine turtles and their nesting habitats along the Lebanese coast suffer from the human pressures, coastal development, fisheries and marine litter. During the survey, 22 dead turtles were recorded from different localities of the Lebanese waters. In this context, a large awareness campaign addressed to the Lebanese public (e.g. fishermen, Non-Gouvernemental Organizations (NGOs), students, tourists and sea-lovers) was conducted to enhance the protection and conservation of the Lebanese marine turtles. For the coming years, it is envisaged that the effects of human impacts on the Lebanese marine biodiversity may intensify (i.e. more related to the oil exploration in the Lebanese waters). In this context, continuous long-term monitoring should be a priority for a better understanding of the effects of human impacts on marine turtles in Lebanon.

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1 Introduction

Two species of marine turtles frequent the Lebanese sea: the loggerheads (*Caretta caretta*) and the greens (*Chelonia mydas*). As on many parts of the sandy Mediterranean beaches, loggerheads and greens females turtles lay their eggs on many Lebanese sandy beaches. Very few studies on marine turtles presence, nesting, abundance and patterns of distribution have been performed along the Lebanese coast. Between 1998 and 2001, a first detailed monitoring of the Lebanese sandy beaches to find potential female marine turtles nesting sites have been done (Hraoui-Bloquet & Sadek, 2003 and references therein). From 2001 to 2005, a re-survey of the Lebanese Mediterranean coast was conducted by MEDASSET in cooperation with the Ministry of Environment in Lebanon (MoE), aiming to assess both potential nesting sites for marine turtles and nesting concentrations (Aurreggi *et al.*, 2005 and references therein). It is worth noting that some potential nesting sites of female turtles (e.g. the beach of Al-Mansouri-south of Lebanon) have been subject of a long term monitoring (Newbury *et al.*, 2002; Khalil *et al.*, 2009), while others (e.g. the two Marine Reserves: Tyre (TCNR) in the south and the Palm Island (PINR) in the north of Lebanon) were monitored sporadically (Aurreggi *et al.*, 2005; Casale & Margalitoulis, 2010 and references therein; El-Shaer *et al.*, 2012). As results of the studies done between 1997 and 2006, the average number of female turtles nests recorded along the surveyed Lebanese beaches varied from 36 ± 52 nests of *Caretta caretta* and 4 ± 14 of *Chelonia mydas* (Tab. 2). In Lebanon, the marine turtles are protected through:

- The Barcelona Convention 1976 signed by Lebanon in 1976
- The Mediterranean Action Plan law, (UNEP) 1975, which attempts to protect the Mediterranean Sea.
- The UN Convention on the Law of the Sea signed in 1995 by the Ministry of Agriculture (MoA) of Lebanon.
- The Decision of the MoA (no. 125/1 of 23/9/1999) banning the fishing of cetaceans, whales, monk seal and marine turtles.

This report represents the results of the monitoring done during the nesting/hatching season of the marine turtles along the Lebanese coast. Its aim to:

- A first large exploration of the Lebanese coastal zone, never done since 2006, to find and determine potential/ or important nesting sites of the two marine turtles (*Caretta caretta* and *Chelonia mydas*).
- Identify the number of female turtles nests on the monitored coastal zone, and count the number of eggs in each nest, when it is possible.
- Count, when it is possible, the number of marine turtles hatchlings, and the unhatched eggs as well as the dead hatchlings.
- Take samples from dead hatchlings and unhatched eggs of the marine turtles for genetics analyzes.
- Precise the important threats on the Lebanese marine turtles.
- Evaluate the quality of the important marine turtle nesting sites by precise the human/natural pressures on the monitored sites.

- Follow the number of marine turtles stranded on the beach, and analyze the cause of death (e.g. by necropsies).
- Raising the awareness campaign of the public (e.g. ecovolunteers, fishermen and tourists) on the importance of the Lebanese marine turtles and the necessity to protect and conserve them.
- Cartography of the important marine turtles nesting sites along the Lebanese coast.

2 Material and Methods

2.1 Description of the Lebanese coast

The Lebanese coastline is about 220 km long from Al-Arida in the north to Al-Nakoura in the south. Pebble beaches and rocky coasts are dominant along the coast, sandy beaches concerning only 20 percent of the coast (Badreddine, 2018). The Lebanese Coastal Zone (LCZ) is narrow (3-7 km wide), and the coastline is characterized by the presence of a few bays (Bay of Beirut, Bay of Jounieh, Bay of Shekka and Bay of Akkar), 4 commercial ports and over 15 fishing harbors, dozens of sea pipelines for petroleum imports, various industries, three power plants and fuel tank farms. The LCZ hosts a wide variety of important ecosystems (Kouyoumjian and Hamzé, 2012). These ecosystems range from shallower features such as vermetid reefs (Badreddine et al., 2019), coralligenous habitat, seagrass meadows and seagrass beds to deep-sea ones such as underwater canyons (RAC/SPA-UNEP/MAP, 2013, 2014; SPA/RAC-UN Environment/MAP, 2017, 2018; Aguilar et al., 2018). Furthermore, Lebanon has implemented two marine protected areas (MPAs), representing Palm Islands and Tyre Coast Nature Reserve. The former was created in 1992, covers an area of 5 km² and was recognized as a Ramsar Site in 2001 (Ramsar, 2017a, 2017b). Recently, the beach of all Abbassiyeh in the south was designated as MPA. However, the LCZ is suffering from many supplementary sources of pollution and human pressures. Coastal development, including the construction of resorts and industrial development has progressed in coastal areas in a chaotic and unregulated manner, particularly during the period of the Lebanese Civil War. This development has affected landscapes and threatened biodiversity, while structures like marinas have disrupted regular water flux, increasing sand deposition (MOE/UNDP/ECODIT, 2011). Most solid waste along the Lebanese coast is discarded, including non-biodegradable plastic (i.e., plastic bags, other plastic debris, lost fishing gear), with deleterious effects on marine fauna including marine turtles. Untreated domestic sewage and industrial effluents represent the main sources of chemical pollution, while episodic pollution events have also resulted in significant impacts on marine life. Unfortunately, the coast of Lebanon has been progressively exploited and regulations are often not respected, resulting in important cumulated human impacts along the coast. In view of the upcoming oil and gas discovery offshore Lebanon, new threats to the marine environment and biodiversity (including marine turtles) are expected to arise related to the construction and operation of offshore installations (oil spills, accidents and blow-outs).

2.2 The surveyed zones

The monitoring was performed along eight sites (including the TCNR represented by the Tyre Marine Reserve and Ras-El-Ain) from the south and five sites (including the PINR) from the north of the Lebanese coast (Fig. 1; Table 1).



Figure 1: Map showing the distribution of the monitored sites along the Lebanese coast

The surveyed sites were chosen according to:

- A large extensive investigation of the Lebanese coast to find potential females turtles nesting sites
- Very few studies on marine turtles nesting sites in Lebanon (Aurreggi et al., 2005; Casale and Margalitouris, 2010 and reference therein; El-Shaer et al., 2012; SPA/RAC–UN Environment/MAP, 2018 and references therein)
- Personal communication with many fishermen and NGOs (especially in the north of Lebanon).
- Googleearth® to identify potential sandy beaches (especially in the north of Lebanon)

It is important to note that sea turtles nesting may occur irregularly at some developed beaches (Fig. 2). Consequently, this option was taken in consideration in this study.

The survey was conducted during the marine turtle nesting and hatchling season from May to the end of September 2019 (Tab. 1). It consisted in a run of all the coast by walking during morning patrols.

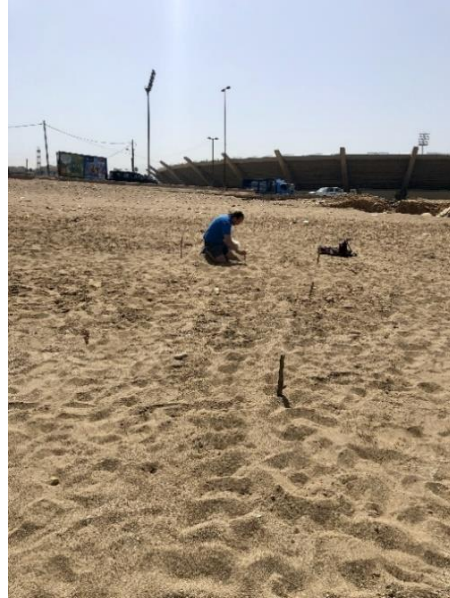


Figure 2: A *Caretta caretta* nest recorded in the developed beach of Tripoli

Table 1

Period per monitoring area during the 2019 season

Area	Stations	Distance (m)	Period
South			
Al-Addousiyeh	ADD	3000	13 May - 30 September
Sarafand	SAR	500	13 May - 15 August
Adloun	ADL	1500	13 May - 10 August
Al-Kharayeb	KHA	1000	13 May - 7 August
Al-Quasmiyeh	KAS	1500	13 May - 1 August
Al-Abbasiyeh	ABB	3300	13 May - 31 August
Tyre	TYR01 (Al-Fanar)	500	13 May - 31 August
	TYR02 (TCNR)	1714	13 May - 31 August
	TYR03 (Ras-El-Ein)	1500	13 May - 31 August
Al-Mansouri	MAN	1400	1 May - 30 September
North			
Chekka	CHE	450	15 May - 15 July
Batroun/Selaata	BAT	200	15 May - 15 July
Tripoli	TRI01	1950	15 May - 15 July
	TRI02 (Palm Island)	200	13 May - 20 June/ 1 July - 15 August
Cheikh-Zennad	CZE	1000	15 June - 20 July

2.3 Description of the monitored sites

The southern part of Lebanon (from MAN to ADD) is characterized by important marine turtles nesting sites and by the largest sandy beach (around 3.8 km²), where the TCNR is located. The area is populated by local and touristic/immigrant inhabitants. There are no pollutant industries around the area. The main impacts are the illegal domestic/urban outfalls, the agricultural discharges, the river runoff and the anthropic pressures

coming from the tourists and fishermen on the littoral and marine resources. The northern part of Lebanon (from BAT to CZE) is characterized by some small sandy beaches with a low possibility of marine turtle nesting sites. The area is heavily affected by urban, touristic and industrial (e.g. thermal and chemical discharges) activities, as well as intensive agriculture practices. It is also affected by many urban and polluted river runoff, the intense maritime traffic and by large seafront dumpsites.

Table 2

Description of the surveyed sites: Distance (m), Morphology, width and description of the beaches

Stations	Distance (m)	Morphology of the coast	Width of the sandy beach area	Description of the beaches
Al-Addousiyeh (ADD)	3000	Sandy+Rocky	5 to 50m	A fine sandy beach with sand dune covered by small vegetation. The beach is used for animal grazing (goats, sheep and cows). Very large agricultural land and many wetlands area located at the back of the beach. Many agriculture runoffs is visible in this area.
Sarafand (SAR)	500	Sandy+Rocky	30m	It is a beach with fine sand with the presence of many kiosks on the coast (especially during summer) and a port in the north of the station.
Adloun (ADL)	1500	Sandy+Rocky	35m	It consists of a beach with fine sand with dunes and large agriculture land in the back with the presence of a new large port in the north of the station.
Al-Kharayeb (KHA)	1000	Sandy+Rocky	25m	It is a beach with fine sand and used by many kiosks (especially in summer).
Al-Quasmiyeh (KAS)	1500	Sandy+Rocky	10 to 30m	
Al-Abbasiyeh (ABB)	3300	Sandy	15 to 60m	A beach characterized by fine sand with some pebble. The beach is undeveloped, with the exception of several small localized buildings. The beach is highly populated by Palestinian refugees with the presence of small agricultural land all around the beach.
TYR01 (Al-Fanar)	500	Sandy+Rocky	5 to 20m	A small beach with fine sand with a small agricultural land in the back of the beach. This area is very urbanized.
TYR02 (TCNR)*	1714	Sandy	50 to 1000m	The TCNR is characterized by three sectors*
TYR03 (Ras-El-Ein-TCNR)	1500	Sandy+Pebble	100 to 1500m	It consists of sand and pebbles. A small wetland and agricultural areas with an army camp are located at the back of the beach. There is a stream flowing into the sea.
Al-Mansouri (MAN)	1400	Sandy+Rocky	10 to 40m	It is a fine sand beach with many dunes covered by small vegetation. There is a large agricultural land in the back of the beach. There is a big private resort close to the beach and many abandoned houses with a small army camp around the beach.
Chekka (CHE)	450	Sandy	40m	A fine sand beach controlled by private sectors (e.g. industries and private resorts and hotels)
Batroun/Selaata (BAT)	200	Sandy	40m	
Tripoli (TRI01)	1950	Sandy	20m	Small sand beach very urbanized with many house on the beach
TRI02 (Palm Island)	200	Sandy	30m	It is an island: the sandy beach area with fine and exceptional sand is characterized by the presence of a large agricultural land with a lot of sandy dunes. It is an important place for many birds.
Cheikh-Zennad (CZE)	1000	Sandy	1000m	It is a very polluted beach with fine sand and pebble, with many wetlands and a river runoff into the sea. Many urban/agriculture outfalls are present in this area.

*The TCNR is divided into three sectors: A-with a length of 654 m, it is a fine sand beach used to put many kiosks (for touristic purpose); B-with a length of 320 m, it is also a fine sandy beach use for recreation and camping and, C- with a length of 740 m, it is the conservative zone: It consists of fine sand with small vegetation covered sand dune. There is a small wetland at the back of the beach.

2.4 Uses, impacts and/or threats

The Use/Impact index (UI, Tab. 3) was calculated to evaluate the human activities in each sites. Subsequently, for each coast of the surveyed sites, land use category (urban, agricultural, industrial, population, sewage outfalls, freshwater input, fishing) was assessed as follows:

$$UI = \Sigma UV/27$$

UI: Uses-Impacts Index

ΣUV: Some of the uses/impact values

The range evaluation values of the use impact were considered (from 3, very important to 2, more and less important and 1, not important).

Table 3
The uses and impacts of the surveyed sites

Use-Impacts/Zones	South of Lebanon								North of Lebanon					
	MAN	ABB	TYR*	KAS	KHA	ADL	SAR	ADD	BAT	CHE	TRI	PAL*	CZE	MVU*
Urbanization	1	2	2	2	2	2	2	2	2	2	3	1	3	3
Beach/Bathing	2	1	3	2	2	2	2	2	2	2	1	1	1	3
Industrial sewage discard	1	1	1	1	1	1	1	1	3	2	3	1	3	3
Domestic sewage discard	1	2	1	2	2	2	2	2	2	2	3	1	3	3
Agricultural sewage discard	1	2	2	2	2	2	2	2	1	1	2	1	3	3
Solid waste	1	1	1	2	2	2	2	2	2	2	2	2	3	3
Ports, Marinas	1	1	1	2	2	2	2	3	2	2	1	1	1	3
Fishing (commercial/spearfishing/lost nets)	2	2	2	2	2	2	2	2	2	2	3	3	3	3
Freshwater input	1	2	2	2	2	1	1	1	1	1	1	1	1	3
Sum of the uses/impact values (ΣUV)	11	14	15	17	17	16	16	17	17	16	19	12	22	27
Uses-impacts Index (UI = ΣUV/27)	0.40	0.52	0.55	0.63	0.63	0.59	0.59	0.63	0.63	0.59	0.70	0.44	0.81	1

*PAL: Palm Island (Marine Reserve of Tripoli); *TYR: It consist the TCNR.

According to Tab. 3, the Lebanese monitored sites are mostly impacted by urban/agricultural discharges, urbanization (especially from tourists) and fishing. The UI index varied from a min of 0.40 at Al-Mansouri (south of Lebanon) to a max of 0.81 at Cheikh-Zennad (north of Lebanon) as the most impacted sites.

N.B: It is important to note that the impact of the pressures on only sandy beaches was taken in consideration.

2.5 The methods

The survey was conducted every day in all the potential turtles nesting beaches of the Lebanese surveyed sites. The beginning and end dates are shown in Table 1. Data collection was made through early morning patrols, by walking, to spot any signs of nesting/or hatchling activities.

The method of monitoring can be resumed (Fig. 4):

- 1- The survey starts in the early hours of the morning to ensure freshness and clarity of turtles and predators activities.
- 2- The location of all emergence tracks was recorded using a Geographical Positioning System (GPS). It is worth noting that the date assigned to every track or nest recorded, corresponded to turtle emergences from the previous night.



Figure 4: **A.** Asymmetrical track of *Caretta caretta* and **B.** Symmetrical track of *Chelonia mydas*

- 3- The tracks (nesting emergence) and also the false crawl (non-nesting emergence) left by nesting females were noted. It is worth noting that the symmetrical tracks correspond to *Chelonia mydas* while the asymmetrical to *Caretta caretta*.
- 4- Finding the nest by analyzing the shape and the patterns of the tracks in the sand.
- 5- Locating the egg chambers by introducing a wooden stick into the sand (known as the probing method)
- 6- Digging the sand to find and to confirm the presence of eggs. It is worth noting that some nests considered threatened by natural inundation (e.g. sea level fluctuation), agricultural runoff or by human pressures (e.g. tourist disturbance) were relocated.
- 7- Protecting the egg chamber of each nest from predators (e.g. crabs and fox) by placing a one-meter square metal grid with 8 x 10 cm mesh size
- 8- The metal grid was covered with sand and left until the nest hatched
- 9- Note the distance of the nest from the sea with a 50m measuring tape and marking the nest location by GPS and put identification marks around the nests.
- 10- Covering and erasing the traces of the tracks and the nests
- 11- After 45 to 60 days, hatchlings emerge from the nest and they were excavated and counted.
- 12- Note the numbers of empty eggshells, non-fertilized eggs, still unhatched eggs, and dead and living hatchlings in the nest.

It is important to note that all the nests recorded were monitored every day until the emergence of the hatchlings, to protect and note any predation or disturbance.



Figure 3: Important steps of the female turtle nest monitoring survey: **A.** Spot the emergence track, **B.** Probing, **C.** Digging, **D.** Find, **E.** Protect the egg chamber, **F.** Marking the nest location and **G.** Erasing the



3 Results

A total of 142 female tracks were recorded in all the surveyed coast (Tab. 4). Among them, 65 representing 46 % were false crawl (non-nesting emergence, Fig. 5B and 5C). The majority of the tracks (with 94%) belong to the loggerhead turtles (*Caretta caretta*) while only 8 tracks belong to the green turtles (*Chelonia mydas*). The majority of the tracks were recorded in the south area with a number of 118 tracks representing 88%, while 41 tracks of loggerheads in the north. The highest number of tracks was recorded in Al-Addousiyeh (south Lebanon) followed by the PINR (north of Lebanon) and the Al-Mansouri and Al-Abbasiyeh beaches (south of Lebanon).

The first two loggerheads tracks were recorded on the 29th May 2019 in the Ras-El-Ain (TCNR) and Al-Mansouri beaches with a pic nesting abundance (118 tracks) in June 2019.



Figure 4: **A.** An emergence *Caretta caretta* (*Cc*) track and **B,C.** Two *Cc* false crawl (non-nesting emergence) from Al-Addousiyeh (south of Lebanon)

Table 4

Marine turtles tracks per species and monitoring area (*Cc*: *Caretta caretta* and *Cm*: *Chelonia mydas*). N.B: One track is defined by the incoming (emerging) and the outgoing (returning) of the female marine turtle

Area	Stations	<i>Cc</i>	<i>Cm</i>
South			
Al-Addousiyeh	ADD	38	4
Sarafand	SAR	3	-
Adloun	ADL	6	1
Kharayeb	KHA	7	-
Al-Quasmiyeh	KAS	5	-
Al-Abbasiyeh	ABB	21	-
Tyre	TYR01 (Al-Fanar)	2	-
	TYR02 (TCNR)	3	-
	TYR03 (Ras-El-Ein)	2	-
Al-Mansouri	MAN	23	3
North			
Chekka	CHE	-	-
Batroun/Selaata	BAT	-	-
Tripoli	TRI01	9	-
	TRI02 (Palm Island)	21	-
Cheikh Zenad	CZE	1	-
Total	-	134	8

3.1 Number of turtle nests recorded in all the surveyed sites

A total of 77 nests were recorded in all the surveyed areas (Tab. 5). Among them, 74 belong to the loggerheads (with 96%) while only 3 nests to the green turtles. The highest number of nests (n=54 representing 85%) was recorded in the south of Lebanon. The beaches of Al-Addousiyeh with 18 nests (30 %) followed by Al-Mansouri 14 (23%) and Al-Abbasiyeh 12 (22%) in the south and the PINR in the north with 17 nests (29 %) were the most important nesting sites.

Table 5

Number of nests laid per species and monitoring area (*Cc*: *Caretta caretta* and *Cm*: *Chelonia mydas*)

Area	<i>Cc</i>	<i>Cm</i>	Total
ADD	16	2	18
SAR	1	-	1
ADL	2	-	2
KHA	2	-	2
KAS	-	-	-
ABB	12	-	12
TYR01 (Al-Fanar)	1	-	1
TYR02 (TCNR)	3	-	3
TYR03 (Ras-El-Ein)	1	-	1
MAN	13	1	14
CHE	-	-	-
BAT	-	-	-
TRI01	10	-	3
TRI02 (Palm Island)	20	-	3
CZE	-	-	-
Total	74	3	80



Figure 5: *Caretta caretta* nests and eggs

3.2 Number of eggs counted in each turtle nest recorded in all the surveyed sites

A total of 4219 eggs (Fig. 6) were counted from the 60 nests recorded in all the surveyed areas of the Lebanese coast. 2840 hatchlings (representing 66 %, Fig. 7) were successfully excavated to the sea from the south of Lebanon. Among them, 2561 (representing 90%) belongs to the loggerhead and 279 (10 %) were green turtles hatchlings. While no successful hatchlings were recorded in the north (Tab. 6). However, 238 hatchlings were killed by crabs, disoriented by light pollution and trapped by solid waste present on the nesting sites. And, 1141 loggerheads were unhatched because of a mix of human and natural pressures.

Table 6

Number of eggs and hatchlings of *C. caretta* per area

Area/Number	Nests	Eggs Laid	Unhatched Eggs	Hatchlings	Dead Hatchlings
ADD	16	1150	400	700	50
SAR	1	70	-	70	-
ADL	2	110	10	89	11
KHA	2	125	20	100	5
ABB	12	840	100	600	140
TYR01 (Al-Fanar)	1	55	55	-	-
TYR02 (TCNR)	3	240	240	-	-
TYR03 (Ras-El-Ein)	1	102	-	102	-
MAN	13	1038	106	900	32
TRI01	10	210	210	-	-
TRI02 (Palm Island)	20	-	-	-	-
Total	74	3940	1141	2561	238

Table 7

Number of eggs and hatchlings of *C. mydas* per area

Area/Number	Nests*	Eggs Laid	Unhatched Eggs	Hatchlings	Dead Hatchlings
ADD	2	216	-	216	-
MAN	1	63	-	63	-
Total	3	279	-	279	-



Figure 6: A *Caretta caretta* A,B. Unhatched eggs C,D. Hatchlings from Al-Addousiyeh (C) and Ras-El-Ain (south of Lebanon)

3.3 Major threats (humans/naturals) on turtles nests along the surveyed sites

The sea turtles nests in Lebanon is under many human/natural pressures (Fig. 8). However, the loss of the turtles nests is more related to human pressures. A total of 17 nests (28 %, with 1141 unhatched eggs) were lost in this survey. Among them, 13 loss nests were related to human pressures. The most important predators of the sea turtles eggs/hatchlings along the Lebanese nesting sites (Fig. 8) are the crabs, foxes and recently the biological pressures represented by the egg infection caused by the macroinsect *Pimelia* sp. (Tenebrionidae, Coleoptera). It is worth noting that the effect of *Pimelia* sp. on the sea turtles eggs is mentioned for the first time in Lebanon. Also, the sand extraction and the uncontrolled tourist pressures (e.g. walking, camping, using vehicles on the beach) on the nesting sites, can be added as major threat.

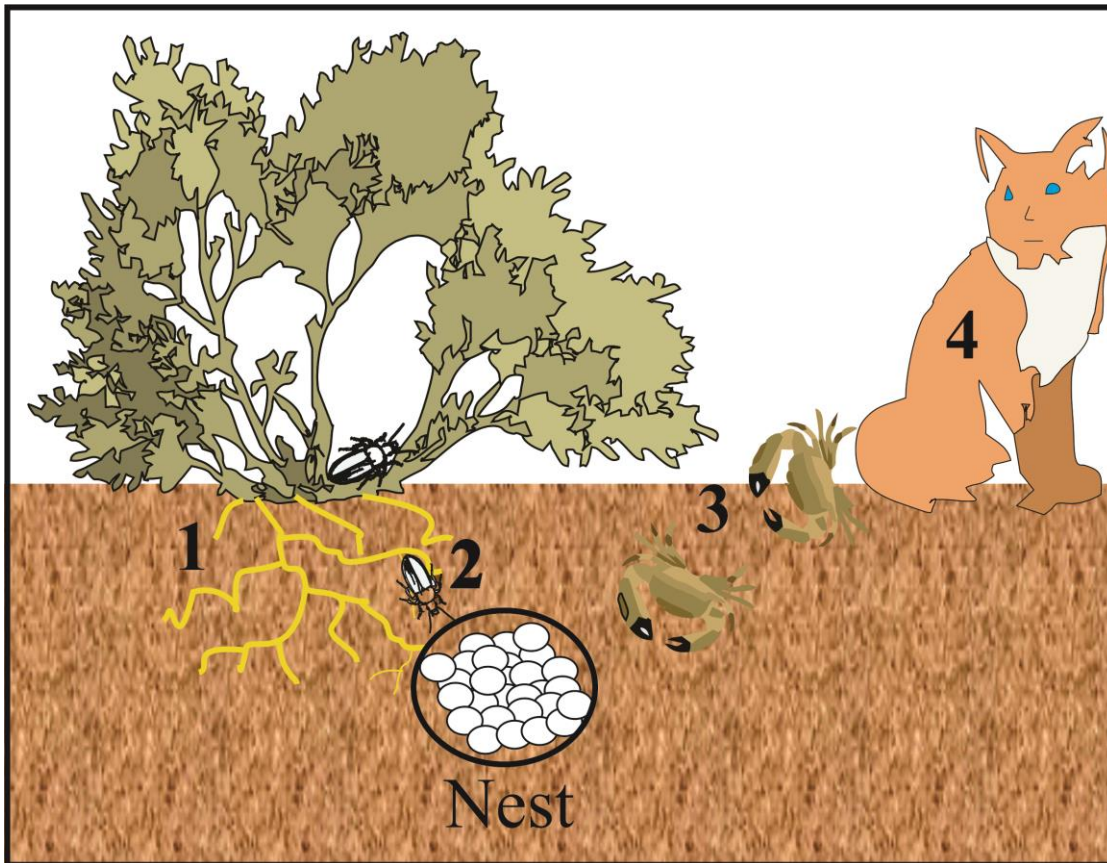


Figure 7: Illustration showing the major predators of female turtle nest in Lebanon. 1- Vegetation roots; 2- *Pimelia* sp. (macroinsect); 3- crabs (especially *Ocypode cursor*) and foxes

Natural pressures (e.g. inundation/humidity from the beach /or the vegetation) are the major reason for the unhatched loggerheads eggs of the 3 nests recorded in the Marine Reserve from Tyre, and the only loggerhead nest from Al-Fanar (TYR01, Fig. 9). The three loggerheads nests recorded from the Marine Reserves of the Palm Island were not followed up for logistical reasons.

Table 8

Number of nests destroyed by natural and anthropogenic causes per area

Area	<i>Caretta caretta</i>	Causes
Al-Addousiyeh	6	Human pressures (e.g. touristic pressures, fishermen, vehicles)/ Invertebrate infestation
Al-Abbasiyeh	2	Human pressures (e.g. Palestinian refugees eats the eggs)
TYR01 (Al-Fanar)	1	Natural pressures (Inundation, nest below the high tide mark)
TYR02 (TCNR)	3	Natural pressures (humidity, sand moistures)
Al-Mansouri	2	Natural pressures (e.g. light pollution)/ Invertebrate infestation
TRI01	3	Human pressures (e.g. inundation)
Total	17	



Figure 8: Unhatched *Caretta caretta* eggs from Al-Addousiyeh and Al-Abbasiyeh because of the infection of the macroinsect *Pimelia* sp. (A and C), crabs (D) and humidity/inundation (B,E)

Unfortunately, 22 dead turtles were recorded during the survey. The main causes of death are more related to the collision of the sea turtles with the fishermen/touristic boat. Furthermore, some of the turtles were accidentally entangled with fishing gears and solid wastes. It is worth noting that sometimes fishermen, especially from the north of Lebanon, kill the marine turtles under the pretext that they tear up the fishing

nets that are very expensive (pers.obs.). Furthermore, some Lebanese people (e.g. divers, kiosk owners) especially around Tyre area are feeding the marine turtles to keep her around the area of feeding to use her as an entertainment tool (pers.obs.).

3.4 Important marine turtles nesting sites in Lebanon

The Lebanese coastline is characterized (Fig. 11):

- In the south by three important marine turtle nesting sites (Al-Mansouri, Al-Abbasiyeh and Al-Addousiyeh), two sites with a moderate frequency of marine turtles nests (The TCNR and Ras-El-Ain), two sites with a low importance (Al-Kharayeb and Adloun) and two sites (Al-Quasmiyeh and Sarafand) with a very low frequency of marine turtles nests.
- In the north by only one site (the Palm Island Reserve) with a moderate frequency of marine turtles nests.

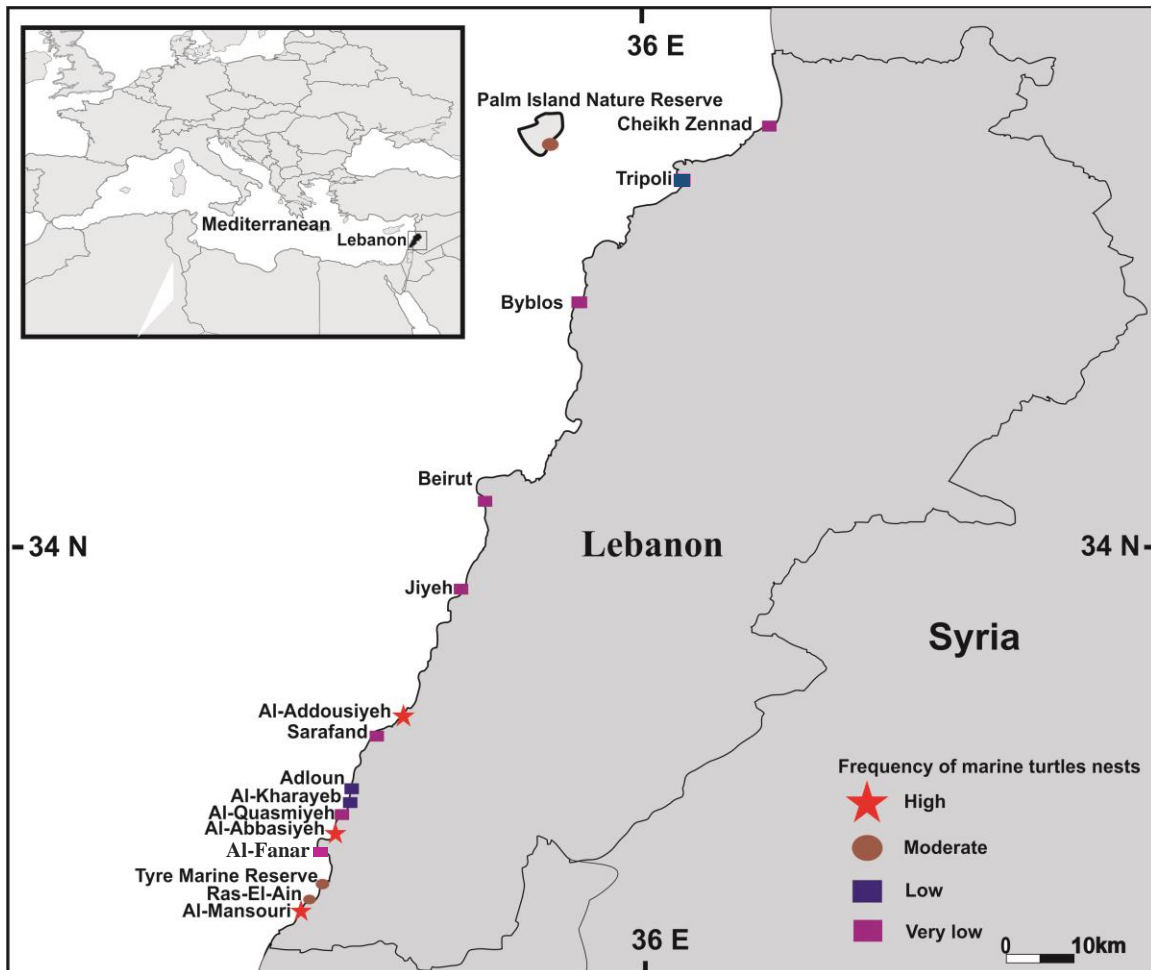


Figure 9: Map of distribution of the potential turtles nesting sites according to their importance (from high to very low) along the Lebanese coast

3.4.1 The three important nesting sites females turtles along the Lebanese coast



Figure 10: The beach of Al-Mansouri (south of Lebanon)

➤ Al-Mansouri (Fig. 12): since 2000, the beach of Al-Mansouri is monitored every year during the marine turtles nesting season by the owner of the Orange House Ms. Mona Khalil and her team. According to the results, the number of *Caretta caretta* and *Chelonia mydas* nests recorded on this beach is significantly decreasing every year: in 2004, the number of *Caretta caretta* nests was 43 in addition to 6 nests of *Chelonia mydas*, while this year (2019), only a total of 14 nests (13 nests belonging to the loggerheads and only one to the green turtle) were recorded. This is due to the high human pressures (especially light and noise pollution; the uncontrolled use of vehicles on the beach) coming from the private beach resort situated near the Al-Mansouri beach as well as the use of illegal fishing methods (e.g. dynamite) around the area.

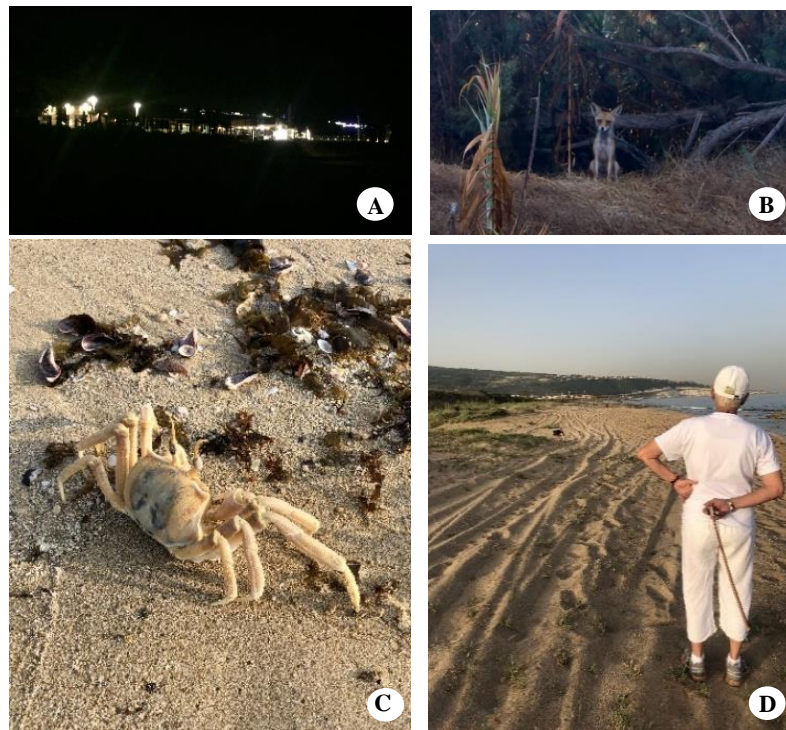


Figure 11: Important threats on marine turtles nests in Al-Mansouri (e.g. **A.** Light and noise pollution coming from the private resort. © Orange House, **B.** Foxes. © Orange House, **C.** the endangered crab *Ocypode cursor* and **D.** Drift vehicles

Al-Addousiyeh (Fig. 15) and Al-Abbasiyeh (Fig. 14): these two sites are characterized by large sandy beaches as potential turtles nesting sites. However, marine turtles nests have never been monitored since 2005 on these two important sites. According to the results of this survey, 12 nests of *Caretta caretta* were recorded at Al-Abbasiyeh while the highest number of nests with 18 belonging to the loggerheads and 2 green turtles were observed at Al-Addousiyeh.

The main treats on marine turtle at the Marine Reserve of Al-Abbasiyeh beach



Figure 12: The beach of the Marine Reserve of Al-Abbasiyeh (south of Lebanon)

Marine turtles at this beach are affected by the direct impact of humans (especially the Palestinian refugees): some of them dig up the turtles eggs for consumption, as well as, the agricultural/urban discharges and the river of El-Quasmiyeh runoff.

The main treats on marine turtles at the most important nesting site (Al-Addousiyeh) along the Lebanese coast



Figure 13: the beach of Al-Addousiyeh (south of Lebanon)

Al-Addousiyeh beach is under many dangerous pressures with a very bad effect on marine turtles in general and their nests in particular:

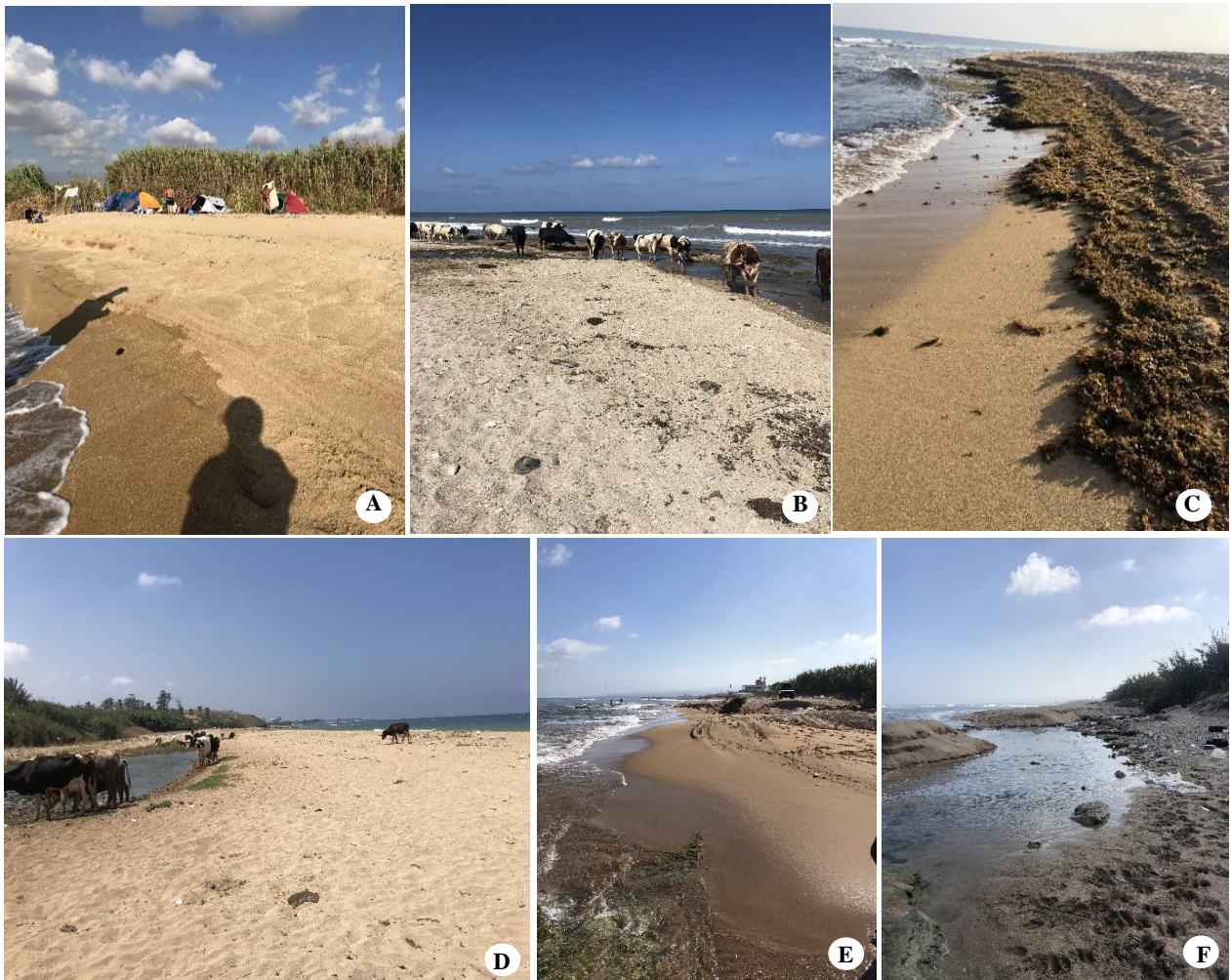


Figure 14: Major threats on turtles nests in Al-Addousiyeh beach (south of Lebanon): **A**. Camping, **B and D**. Livestock, **C**. the presence of macroalgae/marine litter rejected by the sea (e.g. trap the hatchlings) and **E**. Vehicles on the coast, **F**. Agriculture discharge.

- The use of this beach for livestock
- The discharge coming from the agriculture land (it is worth noting that this site is known as the green area due to the presence of the largest agriculture land in Lebanon).
- The presence of the Syrian refugees around many areas of this beach (they are using the beach for anthropogenic activities and some of them dig up the turtles eggs for consumption, pers.comm.public)
- Household waste
- The presence of foxes, stray dogs, jackals and crabs

- The light and the pollution noise especially during the summer (the sea turtles nesting season), coming from the neighboring buildings and from the tourist (e.g. camping) and people coming to this beach.
- The use of this beach to have fun with driving vehicles (e.g. ATV)
- The use of illegal fishing methods (e.g. dynamite)

The Marine Reserve of Tyre (including the Ras-El-Ain site) in the south:



Figure 15: The Marine Reserve of Tyre (south of Lebanon)

The TCNR is characterized by the presence of the largest sandy beaches (1700 km) and the pebble/sandy beach of Ras-El-Ain (1500m). The number of sea turtles nests was 9 in 2005, while in the survey of this year 2019, only three nests of *Caretta caretta* were recorded in the conservative zone of the TCNR and one at Ras-El-Ain. This result is due to the high pressures (e.g. light and noise pollution) coming from the high number of tourists coming every year to this zone, and the agricultural discharge which contains chemical contaminants (especially around Ras-El-Ain area) and the presence of the Palestinian refugees camp of Rachidiyeh (e.g. they are searching the turtle nests for eating the eggs).

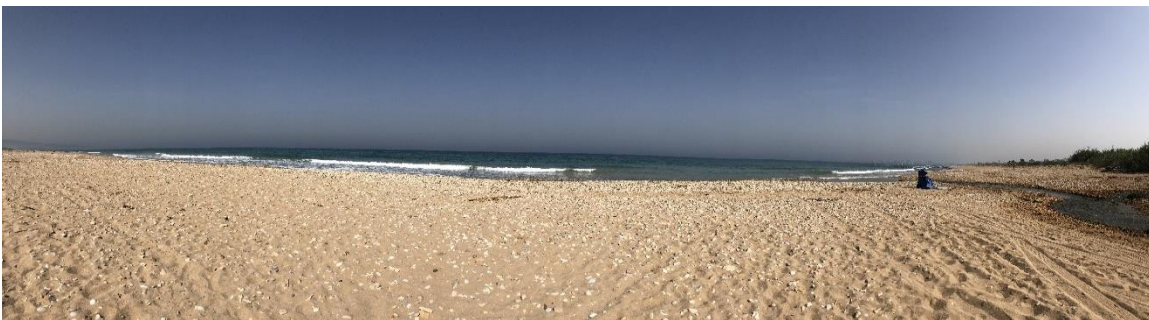


Figure 16: The beach of Ras-El-Ain (the second part of the TCNR)

The Marine Reserve of the Palm Island in the north



Figure 17: The sandy beach of the Marine Reserve of Tripoli (Palm Beach). © H. SAFARJALI

The Palm Island is characterized by a small sandy beach (around 200m). This zone is sporadically monitored during the nesting season. In 2000, around 36 nests of *Caretta caretta* were recorded. Based on the survey of this year, twenty nests of *Caretta caretta* were signaled. Unfortunately, the location of these nests was lost for logistic reasons. However, the major threat to marine turtles nests in this zone is the erosion of the sea waters and the illegal fishing (e.g. dynamites). It is worth noting that also 10 nests were recorded by the team of the Marine reserve

4 The awareness campaign

In Lebanon, the awareness campaign plays a key role in the conservation and protection of sea turtles. This campaign targeting, in general, all the public and local stakeholders and particularly the fishermen, the local population and visitors to nesting areas, beach goers, decision makers at local and regional levels, NGOs, tourists and tourism-related organizations and other stakeholders. Therefore, the awareness campaign focused on the ecological importance of marine turtles in the ocean's ecosystem and the urgency to safeguard their habitats while reducing existing threats. It is worth noting that the main objective of this awareness campaign is to motivate, encourage all the public and especially the ecovolunteers and NGOs to help and participate in the monitoring program during nesting/hatchling season and essentially sharing the informations with the experts, allowing to obtain better results for the protection of the Lebanese marine turtle.

In this context, many actions have been taken this year:

1- On social media: friendly and easy information about sea turtle life (mating, reproduction and hatchlings, monitoring process during the nesting/hatchling season, main threats on marine turtles, advises allowing to help female turtles) have been diffused on Facebook/Instagram through many pages (e.g. Zelehfe, Marine turtles in Lebanon) and personal accounts (e.g. Ali Badreddine). As well as, social media was also used to share some update results of the monitoring survey of the turtle nesting/hatchlings in Lebanon by publishing many turtles hatchlings video, photos of turtle nests, important marine turtle beach.

2- In the field: it was necessary to promote and enhance the cooperation and coordination between the public (e.g. fishermen, ecovolunteers), the organizations (e.g. NGOs, the two Marine Reserve of Tyre and Palm Island, the municipalities) and the expert. In this context, we made to approach this link between all of them by allowing everyone to participate in the monitoring works and by regrouping/sharing all the informations collected during the survey, as well as, we work on increasing the trust between all those organizations.

Also, we allow the public (e.g. family and children) to participate in many activities such as the release of the turtles hatchlings. And some gifts were distributed for free (e.g. tee-shirt, Fig. 20, poster) to the public during these events.

Another important step done in the field, we train many ecovolunteers and NGOs the necropsy method of dead marine turtles especially around Tyre area and in collaboration with the TCNR.



Figure 18: An exemple model of the Tee-shirt distribtued for free to promote the Lebanese public for protect the marine turtle.

It is worth noting that during all those activities, many informations about the marine turtles and their importance and the necessity to save, help, protect and conserve them were shared with all the public.



Figure 19: Some activities done during the survey to enhance the awareness campaign to protect and conserve the marine turtles in Lebanon: training/sharing and participation of many ecovolunteers, fishermen, NGOs in the field survey.



5 The major threats on marine turtles in Lebanon

In Lebanon, as the entire Mediterranean coast, marine turtles are under multiple human pressures coming from different sources:

Solid waste: solid waste is one of the big threats present on the majority of the Lebanese waters and beaches. It is considered a trap for marine turtles in the Lebanese waters (especially the loggerhead, *Caretta caretta*, known as carnivorous species, who confuse them with marine species), as well as, on the coast (e.g. the turtles hatchlings are stuck sometimes in this marine litter on the coast, Fig. 22). From a conservation point of view, it is important to ensure a conservation plan with the Lebanese government preventing the discharge of solid waste especially on important nesting sites (Al-Mansouri, Al-Addousiyeh and Al-Abbasiyeh).

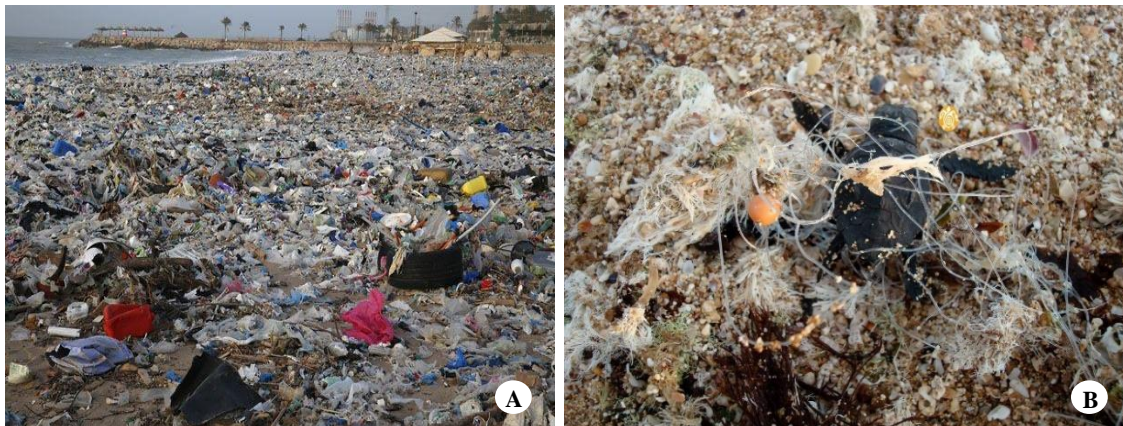


Figure 20: **A.** Solid waste on the beach of Jiyeh and **B.** A hatchling trapped by solid waste on the beach of Al-Mansouri (south of Lebanon). © Orange House

Chemical pressures: It comes in general from the urban and agriculture discharges in the south and industrial and urban discharges in the north and has a very bad toxic effect on marine turtle in waters (Fig. 23).

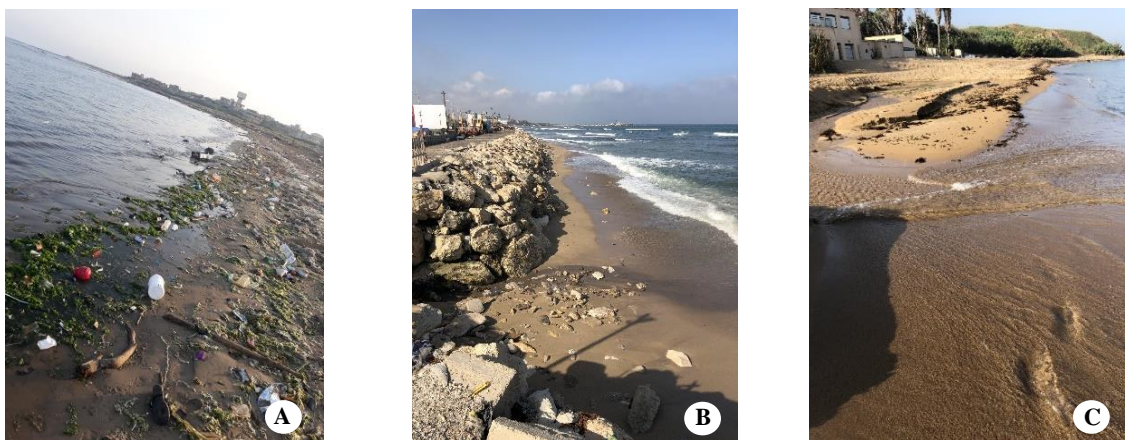


Figure 21: The effect of urban/agriculture discharge on the beach of **A.** Tripoli (north of Lebanon), **B.** Ghazieh and **C.** Al-Addousiyeh (south of Lebanon).

Biological pressures: during the monitoring, a new threat on turtle nests in Lebanon is reported for the first time: the presence of *Pimelia* sp.: macroinsects that eats turtle eggs. This threat is already mentioned in the neighboring countries (e.g. Turkey (Katilmis et al., 2006).



Figure 22.: **A.** *Pimelia* sp. © Google and **B.** The effect on the *Caretta caretta* egg of a nest in

The uncontrolled coastal development: it contributes to the loss of turtles nesting habitats by sand extraction and the destruction of some beaches for touristic purpose (e.g. build private resort/port).

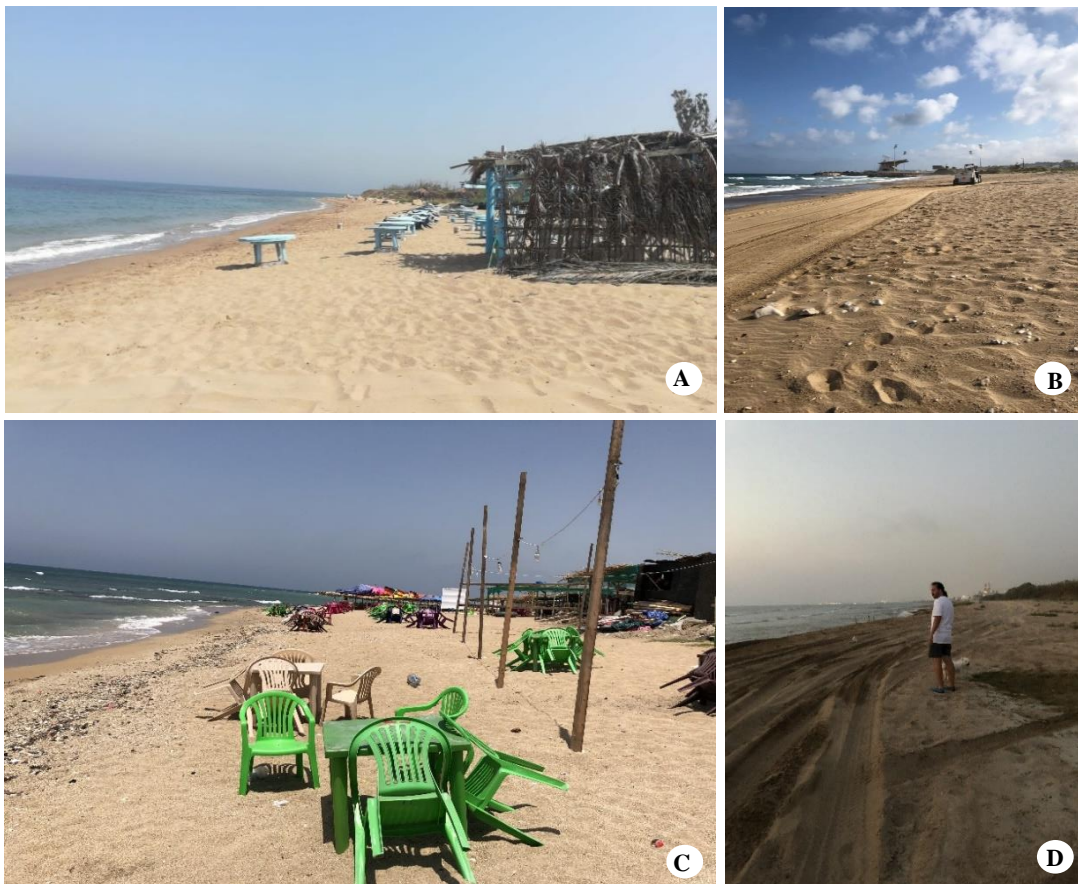


Figure 23: **A.** Some touristic/human pressures on the coast of Al-Kharayeb. © H.Hamza, **B.** Saida (e.g. sand extraction), **C.** kiosks on the beach of Al-Sarafand and **D.** Vehicles drifting on the beach of Al-Addousiyeh

The direct impact of human: Many turtles nests were lost because of touristic pressures (e.g. drifting on the beach, camping, light and noise pollution) and in some area, especially around Al-Addousiyeh and Al-Abbasiyeh sites (south of Lebanon), Palestinian and Syrian refugees are digging up the turtles eggs for consumption (pers.obs.).

Fisheries: It is considered one of the major causes of the death of many individuals of marine turtles in the Lebanese waters (especially during mating/nesting season). Sea turtles are sometimes captured accidentally in the fishing gears and they are abandoned on the beaches /or the waters. Furthermore, the use of the illegal fishing methods (e.g. dynamite, which is prohibited but still practiced) is another threat for the sea turtle. As well as, the collision of the sea turtles with the boat, especially during mating season, is also a reason for the regression of the sea turtle population in Lebanese waters.



Figure 24: Fishing close of the beach of Al-Adoussiye

6 Important steps to protect and conserve the Lebanese marine turtles, especially around the important marine turtles nesting sites (Al-Addousiyeh, Al-Mansouri and the three Marines Reserves of Tyre and Abbasiyeh and Tripoli (the Palm Island))

Don't disturb nesting turtles females: sea turtles can get easily spooked when they're starting the nesting process, sometimes causing them to "false crawl" and return to sea without nesting, in this context it is important to:

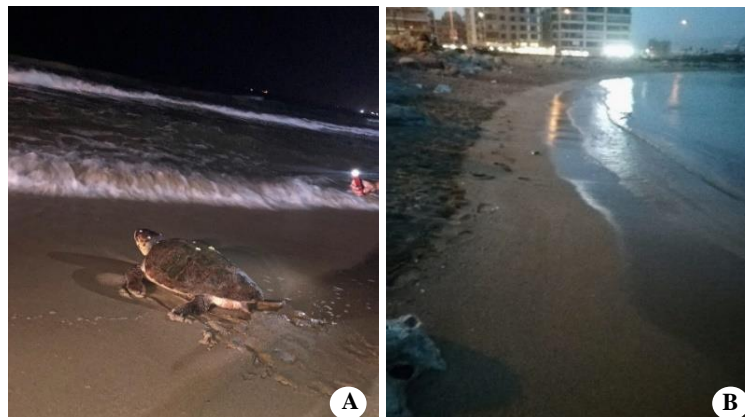


Figure 25: Disturbing a *Caretta caretta* female during nesting in Saida beach and light/noise pollution on the beach of Tripoli. ©

Mohammad

Minimize beach lighting/ or replace the yellow light to a green or a red light:

In general, the moon's natural lighting guides the marine turtles nesting females and hatchlings. The irregular lights can disorient sea turtles and hatchlings. As a solution, it is important to turn off all kinds of lights on the night (Fig. 28), avoid beach fires, especially during the sea turtles nesting season.

Keep all the nesting turtles beaches and waterways free of trash:

It is important to clean all kinds of plastic objects and remove recreational equipment from the beach at night. In this context, it is important to manage many cleaning campaigns of these sites specially before the nesting season.

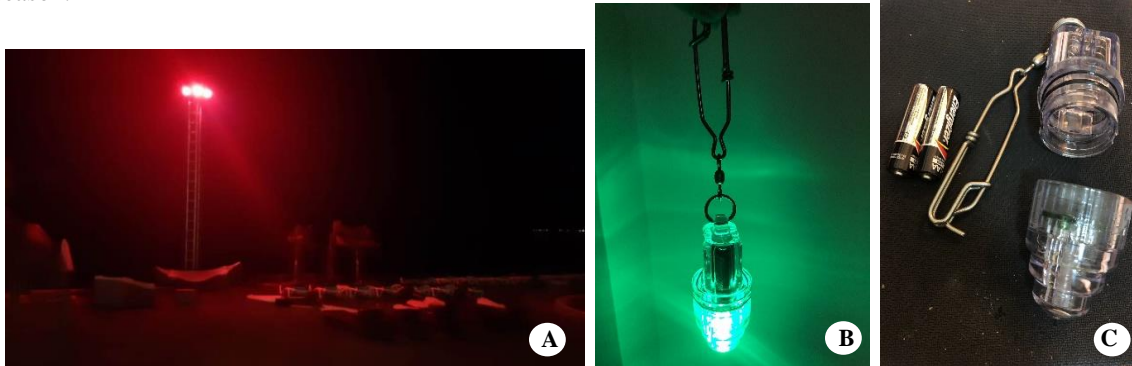


Figure 26: A. A red light from the beach of Al-Mansouri. © Orange House and B,C. new device distributed for free by the TCNR team for the fishermen to keep marine turtles ways from the fishing nets

Enhance the awareness campaign of the fishermen, especially during mating and nesting season:

Stay alert when boating: boat and propeller strikes can seriously injure or kill sea turtles, so to avoid these incidents, it is important to slow down when a turtle is spotted, stay in channels, and avoid boating over their habitat like sea grass beds, especially during mating and nesting season.

7 Recommendations

Despite many important legal texts to manage Lebanese coastal and marine ecosystems, the current set up is still characterized by a lack of transparency in policymaking, allocative and productive inefficiencies, ineffective management, inadequate laws, misinterpretation of legal texts and poor compliance, as well as weak governance and corruption.

In this context and from a conservation and a protection point of view, it is important to:

- Increase the number of Marine Reserves in Lebanon, especially by adding important marine turtles nesting sites like the beaches of Al-Mansouri (south of Tyre) and Al-Addousiyeh (south of Lebanon).
- Set up a regular long term and sustainable monitoring program of the important marine turtle nesting sites (e.g. Al-Mansouri, TCNR, Al-Abbasiyeh, Al-Addousiyeh and the Palm Island). It is worth noting that this monitoring allows estimating the population status (e.g. the exact number of nests per reproduction season) of the two species *Caretta caretta* and *Chelonia mydas* and the variation of number per year.
- Develop the monitoring program of marine turtles by using important techniques such as:

- Monitoring through tagging the females turtles, allowing to follow the movements of the marine turtles in the sea.
- Monitoring through telemetric devices: this method can be useful to count the number of marine turtles in the Lebanese waters and to follow up their movements (e.g. areas of reproduction, hibernation and feeding). It is worth noting that one female of *Caretta caretta* and *Chelonia mydas* were successfully monitored via telemetric device by the TCNR. In this context, it is important to continue the use of these kinds of techniques.
- Monitoring through aerial observations. This method is time and work effectively and allows us to obtain a general distribution of the marine turtles in Lebanese waters and detect any kind of human pressures on the marine turtles.
- Monitoring the turtles nesting sites through drone: this method helps to assess the risk of turtle nesting beaches to sea-level rise.
- Apply the already existing regional legislations (e.g. banning the fishing of marine turtles) concerning the protection of the marine turtles and take new legal steps to ensure the protection of *Caretta caretta* and *Chelonia mydas* and especially during mating and nesting season.
- Enhance the link and the cooperation between NGOs, public, scientists, fishermen and governmental institutes (e.g. MoE, Lebanese University, Ministry of Agriculture) for a long conservation strategy, allowing to create a solid, trained Lebanese team (especially during nesting season).
- Enhance public awareness, especially during the marine turtles nesting season.

8 Major challenges

Oil exploration: In a view of the upcoming oil and gas discovery offshore Lebanon, Lebanese marine ecosystems and biodiversity (including marine turtles) are under multiple and massive threats. For example, airstrikes on a Jiyeh oil storage depot during the 2006 conflict with Israel resulted in a major oil spill, which constituted the largest oil-release accident in the Eastern Mediterranean (Khalaf et al., 2006). A large portion of the coastline was severely damaged, including the nature reserve in the north of Lebanon. In this context and from a conservation point of view, it is important to establish a national contingency plan, allowing us to decrease and manage the anthropogenic impacts on marine biodiversity (including the marine turtles) in the Lebanese waters.

Marine litter: marine litter was present in all the surveyed marine turtles nesting sites along the Lebanese coast. It is worth noting that this waste comes from the ocean currents carrying litter offshore while in other cases, it was apparent that large objects coming from tourists and people. In this context, it is important to improve the disposal and management of solid waste.

9 Conclusion

Since 2006, these works represent the first extensive monitoring survey on marine turtles along the Lebanese coast. In addition to the two Marine Reserves of Tyre in the south and Palm Island in the north, the results show the presence of three other important nesting sites for marine turtles in the south of Lebanon (Al-Mansouri, the Marine Reserve of Al-Abbasiyeh and Al-Addousiyeh). Since no long-term data series for marine turtles nests are available for the Lebanese coast, the present study represents the first assessment of the present state of marine turtles nests in Lebanon, allowing a baseline for monitoring their evolution in the future. According to the results, a total number of 2840 turtles hatchlings were excavated successfully from the Lebanese to the Mediterranean Sea. However, this number is in danger of regression since the majority of the Lebanese coast is under multiple stressors affecting marine turtles. Hence continuous long-term monitoring should be a priority for a better assessment of the effects of human impacts on the evolution of marine turtles. In this context, it is necessary to maintain the good ecological status of the important nesting sites (including the three Marine Reserves) allowing to conserve Lebanese marine turtles current population.

References

- Aguilar, R., Garcia, S., Perry, A.L., Alvarez, H., Blanco, J., Bitar, G, 2018. 2016 Deep-sea Lebanon Expedition: Exploring Submarine Canyons. Oceana, Madrid. 94 p.
- Aurreggi, M., Risk, C., Venizelos, L, 2005. Survey on sea turtle nesting activity South Lebanon (2004). Joint report of MEDASSET and MEDASSETCOAT, 35p.
- Aurreggi, M., Khalil, M., Cross, H., Kasperek, M., Rizk, C., & Venizelos, L, 2006. Five years of marine turtle conservation effort in Lebanon: monitoring and awareness. In Frick, M., A. Panagopoulou, A. Rees and K. Williams (eds). 2006. Book of Abstracts - 26th Annual Symposium on Sea Turtle Biology and Conservation.
- Aurreggi, M., Rizk, C., & Venizelos, L., 2007. Survey on sea turtle nesting activity South Lebanon, 2004.
- Badreddine, 2018. Coastal ecosystems of the Lebanese coast: ecological status, conservation, evolution. Ecosystems. Université Côte d'Azur, 2018.
- Badreddine, A., Milazzo, M., Abboud-Abi Saab, M., Bitar, G., Mangialajo, L, 2019. Threatened biogenic formations of the Mediterranean: Current status and assessment of the vermetid reefs along the Lebanese coastline (Levant basin). Ocean and Coastal Management, 169, 137–146.
- Casale, P., and Margalitouris, M. (Eds.), 2010. Sea turtles in the Mediterranean: distribution, threats and conservation priorities. Gland, Switzerland: IUCN, 294p.
- Cross, H., Bell, S, 2006. Sea turtle monitoring and public awareness in South of Lebanon 2005, 6 (3): 3-27.
- Demirayak, F., Venizelos, L., Sadek, R., Hraoui-Bloquet, S., Khalil, M, 2002. Marine turtle conservation in the Mediterranean – Lebanon: a first survey for *Chelonia mydas* and *Caretta caretta* in Lebanon. – proceedings of the twenty second annual symposium on sea turtle biology and conservation. Miami (in press).
- Hochscheid, S., Kaska, Y. and Panagopoulou, A. (Eds.), 2018. Sea Turtles in the Mediterranean Region: MTSG Annual Regional Report 2018. Draft Report of the IUCNSSC Marine Turtle Specialist Group, 2018.
- Hraoui-Bloquet, S., Sadek, R, 2003. Marine turtles of Lebanon, preliminary records. Zoology in the Middle east, 32: 23-26.
- John, F. S., Khalil, M., & Venizelos, L, 2003. Marine turtle nesting in South Lebanon 2003.
- Kasperek, M., & Aurreggi, M, 2009. Marine turtle nesting in Lebanon. In second Mediterranean conference on marine turtles, 108p.
- Kazour, M., Jemaa, S., Issa, C., Khalaf, G. and Amara, R, 2019. Microplastics pollution along the Lebanese coast (Eastern Mediterranean Basin): Occurrence in surface water, sediments and biota samples. Science of The Total Environment, 696, p.133933.
- Khalaf, G., Nakhlé, K., Abboud-Abi Saab, M., Tronczynski, J., Mouawad, R, 2006. Preliminary results of the oil spill impact on Lebanese coastal waters. Leb. Sci. Journ., 7, 135.

- Khalil, M., Syed, H., Aureggi, M. and Venizelos, L, 2009. Marine turtle nesting at El Mansouri, south Lebanon. In second Mediterranean conference on marine turtles, 109p.
- Kouyoumjian, H., Hamzé, M, 2012. Review and Perspectives of Environmental Studies in Lebanon. INCAM-EU/CNRS Lebanon, pp. 328.
- Katılmış, Y., Urhan, R., Kaska, Y. and Başkale, E, 2006. Invertebrate infestation on eggs and hatchlings of the loggerhead turtle, *Caretta caretta*, in Dalaman, Turkey. Biodiversity & Conservation, 15(11): 3721-3730.
- El-Shaer, H., Samaha, L., Jaradi, G, 2012. Lebanon Marine Protected Area Strategy: Supporting the management of important marine habitats and species in Lebanon. Beirut, Lebanon, Gland, Switzerland y Malaga, Spain: the Lebanese Ministry of Environment / IUCN. 64 pp.
- MOE/UNDP/ECODIT, 2011. State and Trends of the Lebanese Environment. (Ministry of the Environment; United Nations Development Program; ECODIT: Beirut) pp. 355.
- Newbury, N., Khalil, M., & Venizelos, L, 2002. Population status and conservation of marine turtles at El-Mansouri, Lebanon. Zoology in the Middle East, 27(1): 47-60.
- RAC/SPA - UNEP/MAP, 2013. Synthesis report of the ecological characterization of the marine areas of Nakoura, Tyre and Saida in Lebanon. By Ramos-Esplá. A.A., Bitar G., El-Shaer H., Forcada A., Limam A., Oscrá O., Sghaier Y.R., and Valle C. Ed. RAC/SPA - MedMPAnet Project, Tunis: 38 p + annexes.
- RAC/SPA - UNEP/MAP, 2014. Ecological characterization of sites of interest for conservation in Lebanon: Enfeh Peninsula, Ras Chekaa cliffs, Raoucheh, Saida, Tyre and Nakoura. By Ramos-Esplá A.A., Bitar G., Khalaf G., El Shaer H., Forcada A., Limam A., Ocaña O., Sghaier Y.R. & Valle C. Ed. RAC/SPA - MedMPAnet Project, Tunis: 146 p + annexes.
- Ramsar, 2017a. Palm Islands Nature Reserve. <<https://rsis.ramsar.org/ris/1079>>.
- Ramsar, 2017b. Tyre Coast Nature Reserve. <<https://rsis.ramsar.org/ris/980>>.
- SPA/RAC–UN Environment/MAP, 2017. Ecological characterization of potential new Marine Protected Areas in Lebanon: Batroun, Medfoun and Byblos. By Ramos-Esplá, A.A., Bitar, G., Forcada, A., Valle, C., Ocaña, O., Sghaier, Y.R., Samaha, Z., Kheriji, A., & Limam A. Ed SPA/RAC. MedMPA Network Project, Tunis: 93 pages + annexes.
- SPA/RAC–UN Environment/MAP, 2018. National monitoring programme for marine biodiversity in Lebanon; by: Bitar, G., Ramadan Jaradi G., Hraoui-Bloquet S., & Lteif, M., Ed SPA/RAC EcAP Med II project, Tunis, 111 pp.





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