J. Black Sea/Mediterranean Environment
Vol. 27, No. 1: 1-23 (2021)

RESEARCH ARTICLE

Can social media platforms play a role in sea turtle conservation efforts in Libya in times of war and political/economic instability?

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Abstract

Despite the fact that Libya's beaches are considered to be some of the main nesting areas in the Mediterranean Sea of the loggerhead sea turtle, reports on sea turtle stranding in Libyan waters are scarce. Social media platforms offer a cost-effective, alternative resource that can be used to obtain otherwise lost or unavailable information. In the present study, social media platforms were used to assess sea turtles in Libyan waters between 2010-2020. Images (n=177) shared on social media included sea turtle (live and deceased), stranding, nesting activity and egg poaching. From 159 sea turtle related posted at various conditions, 132 were found stranded, of which 34.84 % were related to fishing activity, while, for 53.7% of the cases, it was not possible to determine the cause of stranding. Furthermore, a citizen science network was used to monitor three remote nesting beaches in the centre of Libya between 18 May-3 July 2020, recording 34 nests. The usefulness of social media as a resource for assessing sea turtles stranding and nesting activity along Libyan remote beaches, especially in times of war and political instability, has been demonstrated.

Keywords: Citizen science, Gulf of Sidra, monitoring, loggerhead sea turtle, green sea turtle, leatherback sea turtle

Received: 07.07.2020, **Accepted:** 02.12.2020

Introduction

Sea turtle conservation programs have a long history in the Mediterranean Sea (Kasparek *et al.* 2001; Margaritoulis and Demetropoulos 2003). Amongst the three sea turtle species commonly encountered, both the loggerhead sea turtle, *Caretta caretta* (Linnaeus, 1758), and the green sea turtle, *Chelonia mydas* (Linnaeus, 1758), (Groombridge 1990) use it as breeding ground (Kasparek *et al.*

2001; Margaritoulis and Demetropoulos 2003), while the leatherback sea turtle, *Dermochelys coriacea* (Vandelli, 1761), found mainly in the Atlantic Ocean, is known to occasionally enter the Mediterranean Sea (Candan and Canbolat 2018). In the IUCN Red List of Threatened Species, *C. caretta* is listed globally as 'vulnerable' (Casale and Tucker 2017) and the Mediterranean populations are considered 'least concern' (Casale 2015), whereas both *C. mydas* (Seminoff 2004) and *D. coriacea* (Wallace *et al.* 2013a) are classified as 'endangered'.

Sea turtle protection programs in Libya fall under the patronage of the Libya Environment General Authority (EGA) and are mostly funded by UNEPMAP-RAC/SPA and MAVA (Saied *et al.* 2012; MAVA 2018). With a total of 726-800 nests/season, Libya was classified as the most important nesting ground in the southern Mediterranean Sea (Hamza 2010). Beaches between Misratah and Benghazi represent the highest nesting densities (Laurent *et al*. 1995; Hamza 2010; Casale *et al.* 2018). It is also considered one of the four most important nesting grounds for *C. caretta* in Mediterranean Sea (Laurent *et al.* 1995; Hamza 2010; Casale *et al.* 2018) preceded by Greece with an average 3,472 nests/ season (Margaritoulis and Demetropoulos 2003) and Turkey with an average 2,000 nests/season (Canbolat 2004).

Sea turtle populations face various threats leading to their decline, such as fisheries-related mortalities (Lucchetti *et al.* 2017). Casale (2011) estimated 44,000 sea turtles die annually from fisheries alone out of 132,000 incidentally captured in the Mediterranean basin. Traumatic injuries due to boat collisions (Casale 2011; Wallace *et al.* 2013b; Casale *et al.* 2018) are another factor, while plastic pollution threatens the survival of sea turtles in the Mediterranean Sea and across the globe (Schuyler *et al.* 2014; Digka *et al*. 2020). Furthermore, loss of nesting grounds due to coastal tourism development is also a serious threat (Broderick and Godley 1996; Margaritoulis and Demetropoulos 2003).

Sea turtle live and dead strandings are well documented across the Mediterranean (*e.g.* Belmahi *et al.* 2020) Some of these individuals are treated in one of the 34 sea turtle rescue centres, eight first aid stations and seven informal rescue institutions, largely located in the northern and western Mediterranean Sea, with very few to none in the southern Mediterranean Sea (Ullmann and Stachowitsch 2015). The Marine Research Centre of Tajura (MRCT) hosts the only confirmed rescue centre in Libya, reporting to date only 15 stranded then released individuals of *C. caretta* (Hamza 2010). This number could not possibly reflect the actual situation compared to sea turtle stranding and mortalities reported from the Mediterranean basin (*e.g.* Casale 2011; Wallace *et al.* 2013b; Casale *et al.* 2018).

The sea turtle protection program in Libya faces a combination of challenges that includes lack of funding and lack of essential sea turtle stranding data that is important in planning suitable conservation strategies for sea turtle populations using the Libyan coastline during the course of their life as feeding and nesting grounds (Stoke *et al.* 2015). Furthermore, the dramatic ongoing political unrest forced the monitoring of sea turtle nesting beaches to cease in 2010 and to resume again only recently in 2017 (MAVA 2018). As a consequence, for almost a decade, the majority of sea turtle nesting beaches were left unmonitored and unprotected (Hamza 2010), especially those with low nesting densities.

Social media and citizen science-based projects can offer a cost-effective alternative in megafaunal studies (Gibson *et al*. 2020), and have been successfully used in assessing marine biodiversity in Libyan waters (Rizgalla *et al.* 2019; Rizgalla 2020). Therefore, to overcome some of the above-mentioned hurdles, information on sea turtle stranding, mortality and exploitation along the Libyan coastline were sourced from social media networks. Furthermore, three isolated sea turtle nesting grounds located in the centre of Libya were for the first time surveyed and monitored with a small citizen science project as part of ‘project snowball, a research project aiming at assessing marine biodiversity in Libyan waters.

Materials and Methods

Social media platform data mining

Between January 2019 and May 2020, a number of keywords (using the Arabic equivalent *e.g.* sea turtle, strange, turtle, unknown) were used to search for shared posts on social media platforms (SMPs) such as, Facebook® and YouTube. Eleven groups were systematically screened from the earliest post onwards, since February 2010. Additionally, shared posts from 20 personal SMP pages with open access were screened for sea turtle related posts. Comments to relevant posts were screened for additional information, such as location, time and date. Via the SMP messaging service, 78 recreational and professional fishermen were contacted. Screenshots were taken from relevant posts and sorted in an external drive and posts were saved on the author's SMP page. Permission for the use of selected images used in the present study was directly sought from the SMP group administrator and when possible SMP group members responsible for the posts.

Interviews

Eight SMP users were contacted via the messaging service and phone for the information on human consumption of sea turtle eggs, located in Misratah, Sirt, Ras Lanouf, Zwetina, Benghazi, Tobruk and Al Burdi.

Field survey

Three citizen scientists agreed to periodically screen sea turtle nesting activities at nesting sites in their vicinity located in Alaweja (Ben Jawad), Ras Lanouf and Zwetina. Nests, false crawls and signs of animal foraging were recorded and photographed. Images and GPS coordinate were sent to the author. A local resident in Sirt provided information on nesting activity at a sea turtle nesting ground west of Sirt, but only one survey due to a recent political conflict in the area. Beach nesting densities were tentatively classified according to Casale *et al.* (2018) when applicable; sea turtle crawls were classified following Ningaloo Turtle Program (2015).

Sea turtle identification posted on SMPs

Sea turtle species were identified, when applicable, following sea turtle species identification guidelines (Dodd and Kenneth 1988; Márquez 1990). With the exception of *D. coriacea*, sea turtles with unclear morphological features or at an advanced stage of decomposition were identified as 'sea turtles.

Estimating the size and sexual maturity of sea turtles posted on SMPs

The approximate straight carapace length (SCL) was measured when possible, scaling against known recognisable objects within each photograph as reference points, for example, plastic bottles (see Rizgalla *et al.* 2016). Sea turtles not possible to scale due to missing reference points were referred to as undetermined (Undter). Sea turtles were grouped into three size categories following Casale *et al.* (2011). All sea turtles ranging in size 20-65 cm SCL were classified as juveniles to sub-adults. While *C. caretta* and *C. mydas* size 66-75 cm SCL were classified as adults, *D. coriacea* size 76-150 cm SCL were classified as sub-adults to adults. With the exception of nesting females, due to lack of necroscopy and accurate tail measurements, the sex of all sea turtles was not determined.

Cause for live and dead stranding and carcass decomposition stage

The cause of sea turtle stranding (live and dead) was determined by fishing line and hook (still attached to live or dead individuals), net entanglement, and (or) information provided by the members of SMP groups. Sea turtles with no clear external lesions indicating the cause of stranding were classified as 'unknown'. Decomposition stage of a carcass was classified by visual examination following Flint *et al.* (2009) and Orós *et al.* (2015).

Results

SMP data mining

From 2010 - 2 July 2020, from (*n*=23) cities and locations along the Libyan coastline, sea turtles relating posts (*n*=222) including stranded sea turtles (live and dead), nesting and egg poaching. Only, images, videos and messages (*n*=177) were used for the present study (Tables 1 and 2; Figure 1). The rest of SMP posts (*n*=45) were discarded due to various reasons, such as unclear morphological features and conflict of interest. Sea turtle species (*n*= 166) included *C. caretta* (*n*=141/ 84.9%), *D. coriacea* (*n*= 6/ 3.6%) and *C. mydas* (*n*= 2/ 1.2%), while 17 (4 live and 13 dead) sea turtles (10.2%) remained unidentified. Sea turtle carcasses were either buried (*n*=2), burned (*n*=1), and in the majority of cases left on the beach.

Table 1. Number of posts related to sea turtles (ST) on social media platforms

Year	2010	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Alive ST	1	2	1	10	6	11	4	10	11	14	70
Deceased ST		1	4	13	5	7	11	13	14	21	89
Nesting ST				1			2	1	1	2	7
ST Nest	1								1	4	6
Egg poaching								1		4	5
Total	2	3	5	24	11	18	17	25	27	45	177

Table 2. Species and estimated size of 159 sea turtle stranded along the Libyan coast reported on the social media platforms (SMPs)

Species	20-65 cm	%	66-75 cm	%	76-150 cm	%	Undter	%
Caretta caretta	52	32.7	61	**42.1**	0	**0**	21	13.2
Chelonia mydas	2	1.2	0	0	0	0	0	0
Dermochelys coriacea	0	0	1	0.6	5	3.1	0	0
Total	**54**	**33.9**	**62**	**42.7**	**5**	**3.1**	**21**	**13.2**
Unidentified	3	1.8	0	0	0	0	14	8.8

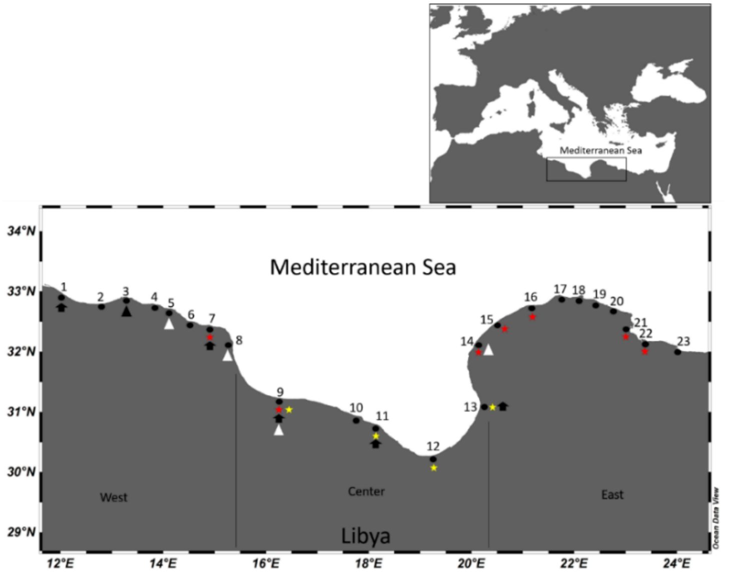

Figure 1. Map of Libya illustrating the locations of 177 records of sea turtle;
i. strandings (*Caretta caretta*: black circle, *Dermochelys coriacea*: white triangle, *Chelonia mydas*: black triangle).
ii. *Caretta caretta* while nesting: red star.
iii. Egg poaching: black arrow. Location of the surveys: yellow star.
a. West (*n*=98; 55.3%) include sea turtle while nesting (*n*=2) & nests (*n*=2),
(b) Centre (*n*=22; 14.4%) and sea turtle nests (*n*=3).
(c) East (*n*=57; 32.2%) and sea turtle while nesting (*n*=5) & nests (*n*=2).
From Cities: 1= Farwa and Zwara; 2= Surman, Zawia and Maya; 3 = Janzur, Tripoli and Tajoura; 4 = Garaboil; 5 = Gasser Kyar and Alalus; 6= Koms, Twebia and Al Dafnia; 7= Misratah; 8= Mahbola (Abugrein); 9 = Sirte; 10= Benjawad; 11= Raslanuf; 12= Marsa Al Brega; 13 = Zwetina; 14 = Benghazi; 15 = Tolmita; 16= Hania; 17= Susa; 18 = Ra's Al Hilal; 19 = Karsa; 20= Derna; 21 = Umm Al Rizam; 22 = Tobruk; 23 = El Burdi.

Sea turtle strandings
In total 159 SMP posts, messages and footages showed live (*n*= 70/44 %) and dead sea turtles (*n*=89/ 56%) (Tables 1, 2, 3) at various conditions. At total of 132 were found stranded, of which 34.84 % were related to fishing activity, 5.3 % related to trauma, 3% torture and intentional killing, 2.27 % predators and 0.7% due to intentional fishing. While, for 53.7% of the cases, it was not possible to determine the cause of stranding.

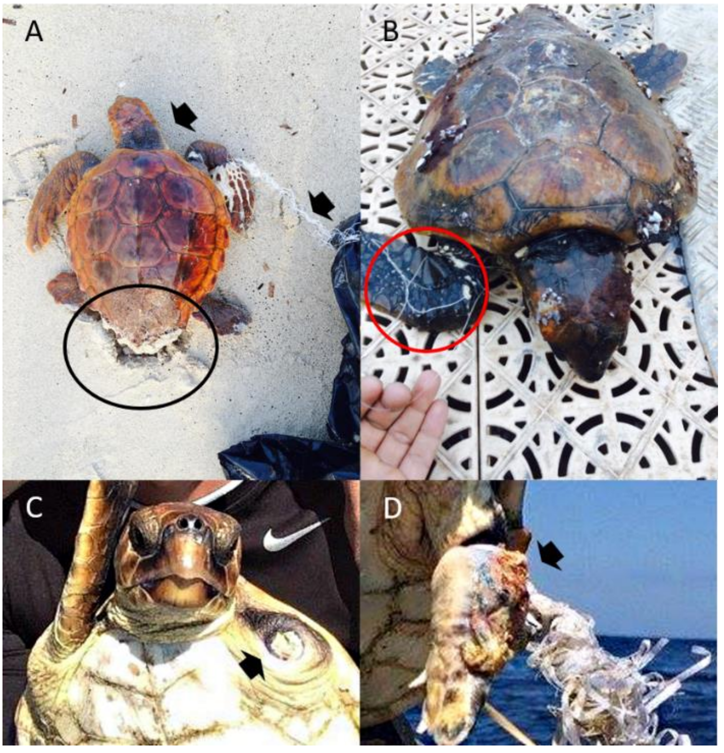

Figure 2. Injuries due to fishing line entanglement observed on three live stranded juvenile sea turtles posted on an SMP. (A) Nylon fishing line (black arrow), attached to a plastic bag entangled around front right flipper leading to the showing signs of erosion and necrosis and active carapace necrosis involving the 4th, 5th vertebral and supracaudal scutes (black circle) (25 September 2014). (B) Sea turtle found in the Sirt Harbour, which had ingested a fishing hook, with a fishing line dangling from the mouth, and entangling the right front flipper. Parts of the carapace were missing, probably due to animal predation (not visible in image) (24 April 2017). (C&D) Live juvenile *C. caretta* found floating on the sea surface at Tripoli, by two recreational fishermen during a fishing trip, the sea turtle had an amputated front left flipper (black arrow) (C) and right rear flipper entangled in nylon fishing line and plastic (black arrow) (probably a plastic bag), deeply cutting into the flesh, causing flipper strangulation and discoloration (15 Sept 2016). All three sea turtles were returned to the sea after cutting the plastic lines. Photos: (A) Ali Alwerfally; (B) Mohammed Libya; (B&C) Abdallah Elmgawshi.

Live specimens included unidentified sea turtles (*n*=4), *C. caretta* (*n*= 62) (of which individuals (*n*=10) were held underwater to 'play' and photograph), *C. mydas* (*n*=1) and *D. coriacea* (*n*=3) (Table 1). *Caretta caretta* (*n*=6) were attached by barnacles *Chelonibia testudinaria* (Linnaeus, 1758) (*n*=1) and *Lepas (Anatifa) anatifera* Linnaeus, 1758, and unidentified algal species (n=3).

Floating or stranded sea turtles (*n*=27) with fishing gear, *i.e.* ingested fishing hooks, entanglement in nylon fishing line, pelagic longline (used by artisanal fishing locally known as 'Bringlai'), land-based recreational longline fishing (locally known as 'Brinmglai Shera') (Figure 5B-C), and fishing net entanglement (*n*=3) (Figure 2). Lesions included oral ulceration, strangulation (congestion) of one or more flippers, linear ulcerative dermatitis and myositis (Figure 2D). Traumatic injuries included amputation of one or two flippers, both healed and fresh, lesions caused by boat and predation (Figure 3A-B-C). A specimen of *C. caretta* was reportedly incapable of submerging following blast fishing. Emaciation (cachexia) (*n*=1) in *C. caretta* was also observed.

Figure 3. Images of sea turtles posted on an SMP, showing (A) a large *C. caretta* with old bilateral front flipper amputation, found stranded in Garaboli (west of Libya), the sea turtle was returned to the sea. (B) A large stranded *D. coriacea* found in Sirte, with fresh injuries and abrasions on dorsal ridges and unilateral right front flipper amputation, also helped to return to the sea (26 May 2018). (C) A large *C. caretta* with a fresh, traumatic longitudinal fracture of the skull, extending naris – frontoparietal, probably due to boat strike. Photos: (A) Foad Fovo; (B) Baker Moftah Wafa; (C) Ahmed Mkhabish.

Caretta caretta were found trapped in the sea water cooling tank of the electrical plants of Benghazi (*n*=1), and the sea water tanks of the desalination plants of Farwa (*n*=1) and Susa (*n*=4), the latter was due to the removal of the protective grid covering the inlet water tube (Table 3).

Table 3. Information and/or condition of 159 live and dead sea turtles posted on SMPs

Condition	**Live**	**Dead**	**Total**
Attacked by predators	no	3	3
Desalination tank	4	1	5
Electrical plant	2	no	2
Accidental fishing	27	19	46
Intentional fishing	1	no	1
Underwater observation	20	no	20
Torture/ intentional killing	3	1	4
Trauma	3	4	7
Unknown causes	10	61	71
TOTAL	70	89	159

One specimen of *C. caretta* was found in Misratah by an electrical plant worker and was released alive thereafter (Figure 4).

Figure 4. *Caretta caretta* found at Misratah's electrical plant inlet pipe inflow struggling to resist suction (A) it was found tied up in crisscross with a cord around all four flippers. Both front flippers are seen engorged from cutting-off of blood circulation, (B) after cutting off the cord, the turtle was brought to a further location where it was released. Photo: Hamza Moktar

The dead sea turtles were at various stages of decomposition (Table 4). *Caretta caretta* (n= 72/ 80.8%) was the most abundant, followed by *D. coriacea* (n= 3/3.3%) and *C. mydas* (n=1/1.2%), and unidentified sea turtles (n=13/ 14.6%). It was not possible to determine the cause of death in sea turtles (*n*=61/68.5%) with no external signs, from photos taken from a distance or showing only parts of the dead animal (Table 3).

Sea turtle mortalities were caused by fishing activity (Figures 5A and 6), traumatic injuries (Figures 7A and B), predation (Figure 7C) and entanglement (Figure 7D) (Table 3). Dead specimens of *C. caretta* were affected by *Chelonibia testudinaria* (*n*=3) and unidentified algal species (*n*=1).

Table 4. The stage of decomposition of dead sea turtles stranded along the Libyan coastline, following Flint *et al.* (2009) and Orós *et al.* (2015)

Decomposition stage	**n**	**%**
Fresh	21	26.9
Bloated	14	17.9
Active decomposition	17	21.7
Advanced decomposition	11	14.1
Dry remains	15	19.2
Not possible	11	12.3
Total	89	

Figure 5. (A) A carcass of *Dermochelys coriacea* found in Marzoga (East of Misrata) and posted on an SMP platform, with nylon fishing line hanging from the mouth, and entangled with a land-based longline fishing gear (also known as 'Kontiki' fishing) still attached to the right front flipper. (B&C) land-based longline fishing ('Kontiki' fishing) equipment (locally known as 'Brengali'), used in artisanal, and recreational fishing made up of two main parts, the first (B) is made up of the sail raft, empty bottles acting as floating devices and a light (torch) and the second (C) a longline holding the fishing hooks. Photos: (A) Mohamed Ateya Marzog; (B&C) Sartma

Figure 6. Dead sea turtles, (A) a fresh specimen of *Chelonia mydas* washed ashore in Tripoli, found with a fishing line in its mouth (17 February 2016). (C&D) The dry remains of a juvenile sea turtle with fishing line protruding from its mouth and in the abdominal cavity (10 March 2020). Photos: (A) Marwan Al Walid; (B&C) Anwaige A. Almasawri

Figure 7. The carcasses of washed ashore sea turtles with traumatic injuries. (A) A carcass in the advanced stage of decomposition, with the carapace covered by algae and with an old healed fracture (yellow arrows, possibly caused by a boat strike) (23 April 2014). (B) The bloated carcass of an adult sea turtle with a decapitated head and a blue nylon line attached to its left front flipper. (C) A carcass missing distal right plastron with the presence of shark bite (24 December 2017). (D) A carcass entangled with a fishing line or parts of a fish net, front right flipper to the neck Photos: (A) Mohamed Abod; (B) Ali Osman; (C) Anas ALdrsee; (D) Kaled Al Barasi.

Caretta caretta nesting activity

Caretta caretta (*n*=7) were photographed while nesting (Table 1; Figure 8) and twice interrupted nesting activity due to human disturbance. Four nests were located in unfavourable sites in a narrow beach (Gordoba) (Figure 8A) and one nest in a gravel rich beach (Susa) (Figure 8B). Four nests were in a populated touristic area (Misratah and suburb of Benghazi) (Figure 8C&D). Live and dead hatchlings were observed from Zwetina and Sirt (Figure 9A&B).

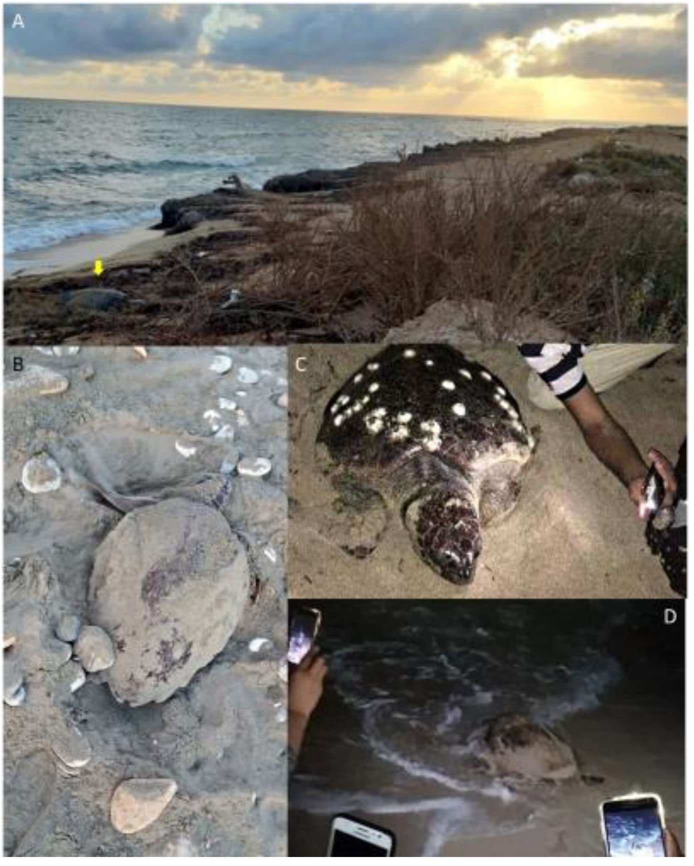

Figure 8. Nesting sea turtles (A) *C. caretta* (yellow arrow) observed nesting in Gordoba in the east of Libya, nest location approximately 5 m from shore line. The turtle was found nesting at 4:45 AM and it returned to the sea at 6:17 AM, (B) Nesting sea turtles in Susa, close to the excavation site of Tolmita, in gravel rich sand (Date). (C) *C. caretta* surprised while nesting in Erzeag (west of Misratah) and was almost run over by a jeep (carapace covered by *Chelonibia testudinaria*). The turtle was photographed using light directly pointed towards the face of the sea turtle (26 May 2018). (D) Nesting *C. caretta* in a suburb of Benghazi rushing to the water following nesting (27 July 2018). Photos: (A) Khaled Yunis Acrym Al- Saet; (B) Walid Al Alwani; (C) Baker Moftah Wafa; (D) Ahmed El Mahjoob.

Egg poaching

Sea turtle eggs were poached (Table 1; Figures 9C and D) and approximately 56 eggs were offered publicly for sale on an SMP group platform from Sirt and Zlitin.

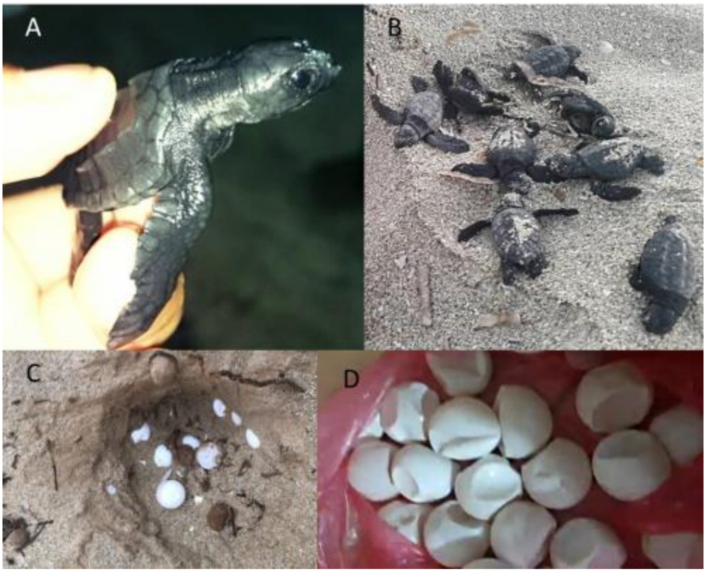

Figure 9. Shared images on an SMP platform of fresh hatchlings (A) campers on a beach in Alagela found hatchings at close proximity to their tent at night; one of the hatchlings was held to take the picture (18 September 2014). (B) Shared pictures via an SMP messenger of dead *C. caretta* hatchlings found in proximity to the nest in Zwetina (26 August 2018). (C) Egg poaching a *C. caretta* nest opened for the removal of (D) 20 eggs per nest for personal consumption in Sirt June 2020. Photo: (A) Hamad Bofarwa Albarasi; (B) Mohamed (Ahmeda) A Alnaas; (C&D) Anonymous.

Interviews

In Sirt and Benjawad sea turtle egg consumption appears to be practiced for generations by people living in proximity to the sea during the sea turtle nesting season. On average, one person (only male) consumes approximately 20-30 eggs every seven to ten days (Figures 9C and D). Only egg yolks are consumed. Reportedly eggs go bad within 4-5 days even if refrigerated, therefore fresh eggs need to be dug out frequently (*e.g.* once every 10 days). Egg consumption for one person ranges from 180 to 900 eggs in 3 months (June-August), approximately 1.5-7 nests are potentially lost to poaching per person.

Field survey

Nests (*n*=34) were recorded from 30 May to 3 July 2020 (Table 5; Figure 10B). On 3 July 2020, an adult *C. caretta* was seen at 5:00 PM laying eggs in Alaweja (Ben Jawad). Ghost crabs were observed feeding on some nests (Figure 10C).

The nesting beach of Zwetina was tentatively classified as moderate-not dense in accordance to Casale *et al.* (2018). In Benjawad one nest recorded on 20 June 2020 was poached a few days later by a local resident who posted the eggs for sale on his private SMP page.

Table 5. Field survey of five nesting beaches by volunteers in Benjawad, Raslanouf and Zwetina (un: unknown)

Observations	**Raslanouf**	**Zwetina**	**Alaweja (Benjawad)**	**Benjawad**
GPS	30°35'55.5"N 18°24'18.3"E	31°03'30.1"N 20°09'42.7"E	30°55'24.5"N 17°51'11.7"E	30°50'36.2"N 17°56'56.5"E
Date	18 & 19 May	30 May; 4 & 27 June	26&30 June; 3 July	29 June
Number of surveys	2	3	3	1
Beach length	1 km	3 km	un	500 m
Nests per survey	(1); (1)	(1); (7); (15)	(1); (5); (2)	1
Total nests	2	23	8	1
Crawling track	3	(3); (8); (10)	none	none
Substrate	Mixed	Sandy	Mixed	Sandy
surveyed area	2 km	3 km	not	not
Distance between nests	1.40 km	5 m	not	A few meters
Distance between home and beach	1 km	150 m	25 km	un
Indication for egg poaching	Yes	Yes	Yes	No
Residential area nearby	Yes	No	No	No
Disturbed nest	-	-	1	-

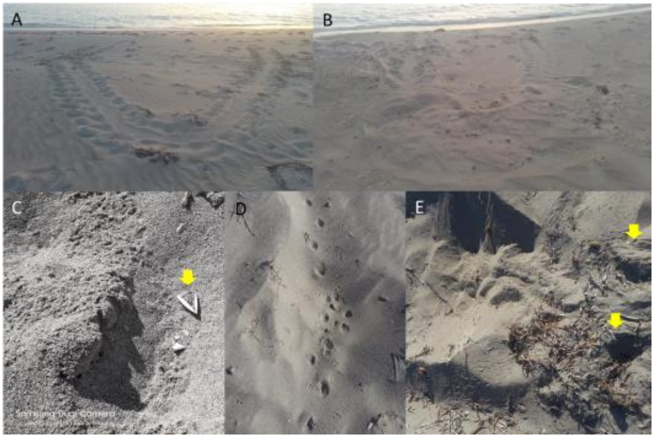

Figure 10. *Caretta caretta* nesting activity reported through the micro citizen science project Snowball. (A) False crawls and (B) nest (4 June 2020). (C) Preyed nest by crabs (D) some animal foot prints on the nest (E) poached nest (yellow arrow) (3 July 2020) in Alaweja west of (Benjawad). Photo: (A&B) Mohamed (Ahmeda) A Alnaas; (C&D&E) Anwar Abd Aslam Aalh

Discussion

Assessing sea turtle stranding in Libya is challenging. However, this study has shown that SMPs can prove useful in collecting information on sea turtle stranding on the Libyan coastline. This agrees with similar observations using social media as a cost-effective alternative for the study of megafauna (Gibson *et al.* 2020). From 177 images and videos posted from 23 Libyan cities, C. *caretta* formed 84.9% of reported sea turtles. This comes as no surprise as it is the most abundant sea turtle species in the Mediterranean Sea (Margaritoulis and Demetropoulos 2003), in addition to the fact of Libya's importance as the feeding, breeding and nesting ground for this species (Margaritoulis and Demetropoulos 2003; Canbolat 2004; Casale and Margaritoulis 2010; Stokes *et al.* 2015). Consistent with reports from neighbouring countries (Karaa *et al.* 2013; Belmahi *et al.* 2020), both *D. coriacea* (3.6%), and *C. mydas* (1.2%) were the least reported.

Stranded sea turtles comprised 55.9 % dead and 44% live sea turtles. More cases were reported from the west (55.3%), in comparison to the centre (14.4%) and east (32.2%) on the Libyan coast. The difference between the three regions could be explained either by a potentially higher artisanal fishing pressure mostly concentrated in the west (Shakman and Kinzelbach 2007), which is known to be one of the main causes for sea turtle stranding (Casale 2011; Levy *et al.* 2015; Başkale *et al.* 2018; Casale *et al.* 2018; Sönmez 2018). Furthermore, the west is a known as a neritic foraging and wintering site for sub-adult to adult *C. caretta* (Casale *et al.* 2018), a size class often affected by artisanal fishing (Başkale *et al.* 2018), causing 38% of stranded sea turtles in this study.

On the other hand, stranding events might simply pass unnoticed along Libya's scarcely urbanised central region (Shakman and Kinzelbach 2007). Epperly *et al.* (1996) estimated that only 7-13 % of dead sea turtles get washed to shore, the rest often fall to predation or are lost due to other causes. This suggests that a potentially much higher undetected sea turtle mortality takes place along Libyan waters, including locations around major cities potentially forming sea turtle stranding hotspots, and need to be further assessed.

Amongst various fishing methods and gears related to sea turtle stranding in the Mediterranean basin (Levy *et al.* 2015; Sönmez 2018; Belmahi *et al.* 2020), recreational fishing is a fishing method inconsistent and difficult to assess (Heaton *et al.* 2016). Land-based longline fishing practices, targeting pelagic fish, is used by recreational fishermen (unpublished data, JR). This fishing method, is gaining popularity among recreational fishermen, with uncertain effects on sea turtle survivability, and needs to be assessed in the future.

Lesions due to traumatic injuries were observed on sea turtles with single or dual (multiple) flipper amputation (Wyneken *et al*. 2006). Head and carapace fractures were observed on 5.4 % of stranded live and dead sea turtles possibly caused by boat collision (Flint *et al.* 2009; Sönmez 2018). Observations were in line with similar reports from the Mediterranean Sea causing 3.9 % sea turtle stranding (Casale *et al.* 2010). Although sea turtles with a fractured carapace show a good prognosis (Wyneken *et al.* 2006), it could lead to stranding and/or death if left untreated.

Another most worrying issue is the use of blast or dynamite fishing in Libya, which is prohibited by Libyan law (Reynolds *et al.*1995). It is a fishing method practiced worldwide with well-known negative effect on small-scale fishery, environment and animals (Glaser *et al.* 2015; Katikiro and Mahenge 2016) and requires monitoring, assessment and control by relevant governmental bodies.

Furthermore, entrapment in the tanks of power stations and desalination plants (Casale *et al.* 2010; Levy *et al.* 2015), probably due to the absence of cover *i.e.* metal grid, can be avoided with minor repairs *e.g.* replacing missing protection grids.

Intentional killing has long concerned sea turtle conservationists. Reports show that they are often killed outright following an accidental catch (Hamza 2010; Casale 2011) or by spearfishing (Broderick and Godley 1996; Casale *et al.* 2018). While it could be argued that the reason for most of these killings could be due to fishing gear destruction or competing over the same fish (Broderick and Godley 1996), it by no means pardons inflicting harm on a helpless animal. It was not possible to determine the cause of mortality for 55.9% of stranded sea turtles, mostly due to the lack of external signs. Therefore, underlying health conditions (Orós *et al.* 2005; Matiddi *et al.* 2017), drowning or entanglement in gill nets and ghost nets, commonly used in Libyan waters and which are known to cause sea turtle mortalities (Alessandro and Antonello 2010), might account for some of these strandings.

It was observed that sea turtles were almost run over cars in remote areas. They were disturbed while nesting, in both remote and urbanised beaches, then forced back to the sea by flashing cameras. While sea turtles can usually tolerate minor interference at onset of egg laying, *e.g.* tagging and measuring (Eckert and Beggs 2006), it does not include touching the animal and using a camera flash (Pierre-Nathoniel 2006). It is crucial to implement a systematic public awareness campaign to inform the general public about the importance of sea turtles and to understand their role in these efforts (Margaritoulis and Panagopoulou 2010; Hassan *et al.* 2017).

The potential loss of sea turtle nesting beaches to urbanisation is an additional and most worrying issue. Nesting beaches create a socio-economic controversial issue due to clashes between sea turtle protection efforts and tourism (Margaritoulis 2005; Ga-Young and Eckert 2009). Whilst, due to decades of political isolation followed by a decade of violent conflict, Libya's touristic sector, in contrast to other Mediterranean countries, is far from being used. Beaches (*e.g.* in Misratah, Sirt and Benghazi and its suburbs), considered important nesting beaches in Libya (Casale *et al.* 2018), are increasingly used by local tourism. The effect of this human interference is yet to be assessed.

Historically sea turtles were fished to over-exploitation for their meat (Casale *et al.* 2010), and while, thanks to implementing various protection programs and awareness campaigns, consumption of sea turtles has declined, the catching of sea turtles remained a common practice in several regions including the Mediterranean Sea, *e.g.* Egypt (Nada and Casale 2010; 2011). In Libya, despite the laws prohibiting sea turtle egg and meat poaching, egg poaching is still sporadically practiced (Hamza 2010). Evidence from the posts on the SMP and interviews showed a continuation of this practice, not only by the local population living in proximity to nesting grounds, but has become a commodity offered for sale on the SMP, praised for its effects on 'virility' (Hamza 2010) or eaten fried as 'energy food'. An estimated 1.5-7 nests/season are consumed per person, amounting to staggering numbers of potentially lost nests each year. Egg poaching is considered one of the main threats to sea turtle survivability (Santidrián Tomillo *et al.* 2008) and a trend, if not controlled, that has the potential of affecting *C. caretta* survivability in Libya and the Mediterranean Sea.

In Libya only a handful of nesting beaches are systematically or periodically monitored and protected (Hamza 2010) during a nesting season, typically extending from end of May to early September (Hamza 2010; Casale *et al.* 2018), leaving out remote beaches with low nest densities. Three small citizen science projects periodically monitored remote beaches with the help of volunteers from the local population, jointly recording 34 *C. caretta* nests. Although the survey was discontinued due to Covid-19 lockdown, the beach in proximity to Zwetina was tentatively classified as moderate-not dense in accordance to Casale *et al.* (2018), a good candidate to be included in future protection programs. Furthermore, this approach could help assess remote and inaccessible beaches, potentially recruiting, as shown in the present study, local residents interested in sea turtle protection.

There are a number of pitfalls coupled with the use of SMPs (Rizgalla *et al.* 2016). The lack of necroscopy findings hindered in determining the cause of mortality in more than half of the stranded sea turtles. Furthermore, sieving through SMP posts is a time-consuming method, requiring sorting out reposted images over different years and amongst different groups, verifying posts authenticity and fact checking (Rizgalla *et al.* 2016; AAP factcheck 2019). The nature of the information mostly lying in the past meant that none of the sea turtles can receive medical attention when needed. Despite these difficulties, social media platforms and citizen science projects have proven to be important and cost-effective (Cigliano *et al.* 2015; Gibson *et al.* 2020), with a serious potential in playing a positive role in sea turtle conservation efforts in Libya and by paving a direct link between sea turtle protection bodies and the most remote areas. They could be employed to build an effective stranding network and help monitor remote and inaccessible beaches which would help safeguard sea turtles in Libyan waters and consequently the Mediterranean basin as a whole. The present study is part of ‘Snowball’, a citizen science and filed survey-based project assessing marine biodiversity in Libya waters.

Acknowledgment

The author wishes to thank the two anonymous reviewers and Ayaka Amaha Ozturk for their comments and suggestions which have improved the quality of the manuscript. The author would like to thank Sophie Fridman for constructive criticism of the manuscript. Thanks are due to, Hamad Bofarwa Albarasi, Ali Alwerfally, Mohammed Libya, Abdallah Elmgawshi, Foad Fovo, Baker Moftah Wafa, Ahmed Mkhabish, Hamza Moktar, Mohamed Ateya Marzog, Sartma Marwan Al Walid, Anwaige A. Almasawri, Mohamed Abod, Ali Osman, Anas ALdrsee for allowing the use of images and for the shared information. Thanks, are also due, to the administrators of the Facebook groups, Libya youth, fishing and angling, Sartma, Tobruq fishermen, Green footprint and spearfishing in Libya for allowing the use of information posted on their FB groups. The author is grateful to all members of the various Facebook groups who responded to inquiries providing useful information and images of sea turtles. Ahmed Alqasi, Anas Shamli, Anwar Abd Aslam Salh, Said youssif and Khaled Yunis Acrym Al- Saety, Mohsen Tarhuni (Black), Seraj Abduljawad, Hakeem Elshegmani, Marwan Al Walid, Kaled Yosof Sayeti, Ali Mohamed Al Boshweder (Libyan society for the protection marine biology), Muftah Albrany, Fatouma Najeeb Bendardaf, Ali Eshkerban, Mostafa Al Azozy, Ayad Najaa, Ahmed Al Kasali, Monsef Abd Alhak, Hamza Mukhtar, Ahmad Mansour, Ayob Al Forgani, Youssif Ibrahim Ali, Younes Bo sahib Elsobhi, and Adel Alanabi are thanked for provided information on sea turtle stranding and mortalities. Special thanks are due to Mohamed (Ahmeda) A Alnaas, Anwar Abd Aslam Salh, said youssif and Khaled Yunis Acrym Al- Saety for taking part in the micro citizen science project 2020, surveying and recording sea turtle nesting activity.

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