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Update of the Leatherback sea turtles *Dermochelys coriacea* (Vandelli, 1761) and Green turtles *Chelonia mydas* (Linnaeus, 1758) observations in Italy (Reptilia Testudines)

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ABSTRACT In this work, we collected records since 2002 of Leatherback sea turtle *Dermochelys coriacea* (Vandelli, 1761) and since 2009 of Green turtle *Chelonia mydas* (Linnaeus, 1758). These observations have been made using scientific literature, citizen science programs, and social networks as data sources (Reptilia Testudines: Dermochelyidae and Cheloniidae). The aim of this work is to create a complete and up-to-date dataset. About one fifth of these new records comes from Facebook groups dedicated to biodiversity, thus underlining the usefulness of unconventional sources to gather data on species with poorly known distributions.

KEY WORDS Marine turtles; Distribution map; Estimation; 77744Trend; Mediterranean Sea.

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INTRODUCTION

The Leatherback sea turtle *Dermochelys coriacea* (Vandelli 1761) (Reptilia Testudines: Dermochelyidae) is the largest of all living turtles in the world (McClain et al., 2015) and is a circumglobal species, with the widest range of all reptiles (Fig. 1). Nesting colonies are distributed mainly in the tropics, but the Leatherback sea turtle regularly lives in temperate seas during its trans-oceanic journeys (Hays et al., 2004; James et al., 2005). This species feeds upon pelagic invertebrates, and undertakes one of the longest migrations in the animal kingdom (Bjorndal, 1997). Pan-oceanic movements and shallow diving make these turtles particularly vulnerable to pelagic long-lining that is considered the major source of leatherback mortality worldwide (Spotila et al., 2000; Lewison et al., 2004). Incidental catches and its potential deadly effects, along with egg harvest, have resulted in the severe reduction of populations and this species being listed globally as critically endangered (Hilton-Taylor, 2000). The alarming decline of over 90% on nesting beaches in the Pacific Ocean over the last two decades (Chan & Liew, 1996; Eckert & Sarti, 1997; Spotila et al., 2000) has brought Pacific leatherbacks to the verge of extinction, with the adult female population being less than 2,300 individuals (Crowder, 2000).

Besides the two sea turtle species that reproduce in the Mediterranean, the Loggerhead *Caretta caretta* (Linnaeus, 1758) and Green turtle *Chelonia mydas* (Linnaeus, 1758) (Cheloniidae), leatherbacks regularly frequent these waters, most likely originating from Atlantic populations (Lescure et al., 1989; Casale et al., 2003). *Chelonia mydas* population represents an independent RMU (Wallace et al., 2010).

The concept of the marine turtle 'regional management unit', or RMU, was developed in 2010 to provide a globally consistent, biologically relevant framework for defining conspecific marine turtle assemblages below the level of species but above the level of individual MUs or breeding rookeries that share marine habitats (Wallace et al., 2010). With this paper we therefore review information on *D. coriacea* and on *Chelonia mydas* in Italy based upon bibliographic data or estimated from photo or video documentation and discuss the role of citizen science.

MATERIAL AND METHODS

Photographs of *Dermochelys coriacea* and *Chelonia mydas* taken in Italy were obtained from various web sources. First, the following sites were checked: tartapedia.it; geocetus.it; fondazionecetacea.org; ansa.it and biologia.unipd.it.

Then, we used the web-application Morphic (Leighton et al., 2016), which allows users to specify search terms and retrieves photographs from the search engine Googleimages®. We used "green sea turtle" "tartaruga verde", "green turtle", "*Chelonia mydas*", "Tartaruga Liuto", "*Dermochelys coriacea*" and "Leatherback sea turtle" as a search term and narrowed the search to Italy. Only those reports supported by photographic material allowing reliable identification of the species were chosen. We excluded all records of *Dermochelys coriacea* and *Chelonia mydas* sightings where neither the turtle nor a photo could be inspected by an expert (Tables 1, 2).

This web application (http://morphs.io), free and open source, is based on a perpetual hashing algorithm (Niu & Jiao, 2008) that enables to remove duplicate photographs and avoids geographical biases using Google's Hummingbird relevance algorithm (Chauntelle & Yazdanifard, 2014). To further re-

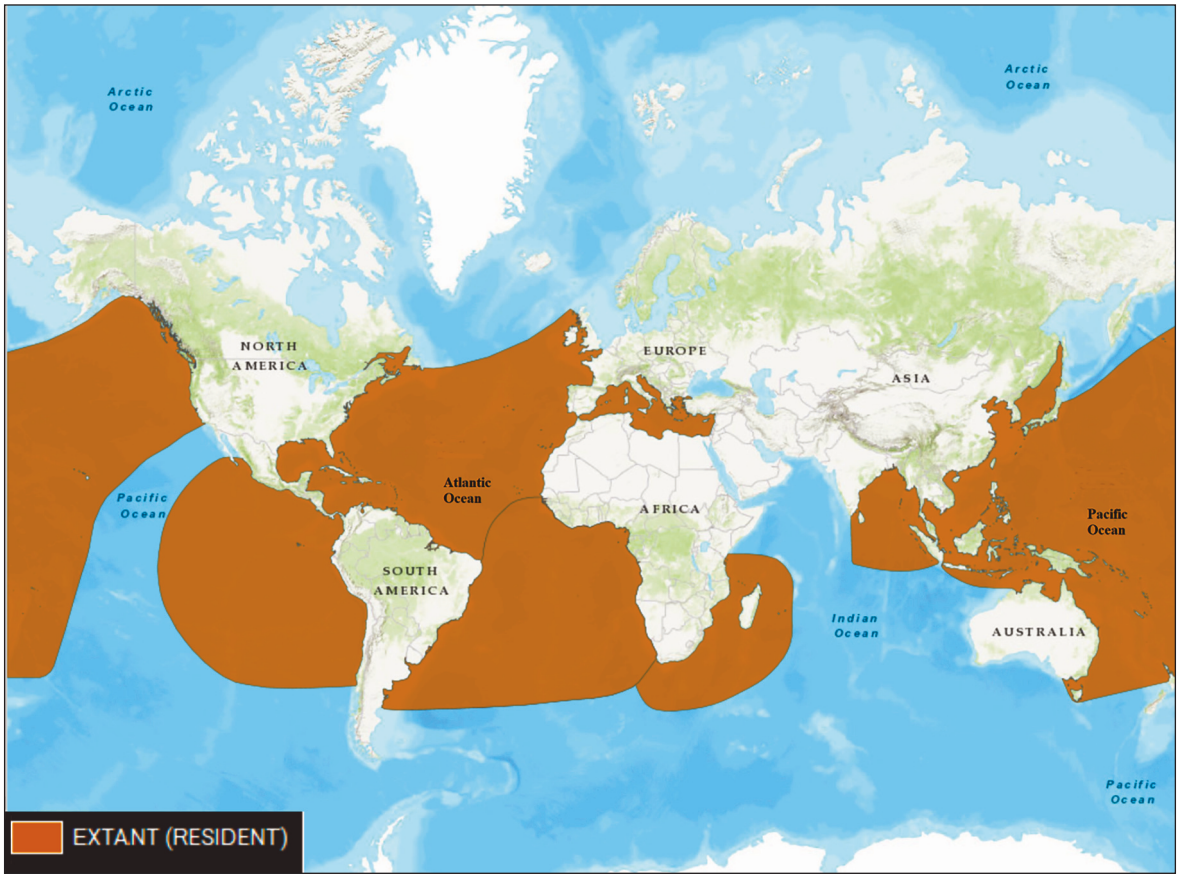


Figure 1. Distribution of Leatherback sea turtle *Dermochelys coriacea* (modified from Wallace et al., 2013).

N.	Date	Sex	Lenght (m)	Remarks	Localities	Province	Source	Sitography
1	February 25, 2001		1.25 (L)	Dead	Salerno	SA	CSC, 2004a	
2	June 1, 2001		1.6 (TOT)	Live	Joppolo	VV	CSC, 2004a	
3	August 10, 2002		1.35 (CCL)	Dead	Gaeta	LT	CSC, 2004b	
4	April 12, 2004		0.4	Dead	Salina	ME	Lo Cascio, 2020	
5	September 18, 2005	ND	1.85 (TOT)	Dead	San Vincenzo	LI	CSC050918TDc1 (2)	
6	June 29, 2007			Dead	Santa Margherita Ligure	GE	Oneto et al., 2021	
7	June 2, 2009	F	1.38 (CCL)	Dead	Lido di Venezia	VE	Garofalo et al., 2020	
8	February 16, 2011	F	1.39 (CCL)	Live	Realmonte	AG	Caracappa et al., 2017	
9	June 6, 2011			Dead	Genova	GE		1L
10	August 1, 2011			Dead	Portoferraio	LI		2L
11	September 10, 2011			Live	Alghero	SS		3L
12	August 12, 2012			Dead	Portovenere	SP		4L
13	October 11, 2013	F	1.73 (TOT)	Dead	Lamezia Terme	CZ	CSC131011TDc1 (2)	
14	August 15, 2014			Dead	Lampedusa	AG		5L
15	August 21, 2014	ND	1.22 (CCL)	Dead	Laigueglia	SV	CSC140821TDc1 (2)	
16	September 19, 2014	F (4)	1.75 (CCL)	Live	Gizzeria	CZ	CSC140919TDc1 (2)	
17	October 3, 2014	F	1.47 (CCL)	Dead	Chioggia	VE	Garofalo et al., 2020	
18	July 12, 2015	M	1.7 (CCL)	Live	Davoli	CZ	CSC150712TDc1 (2)	
19	August 3, 2015			Live	Carrara	MS	ARPAT, 2016	
20	August 12, 2015	M	2.04 (CCL)	Dead	Alassio	SV	CSC150812TDc1 (2)	
21	May 15, 2016	ND	1.10 (CCL)	Dead	Menfi	AG	Caracappa et al., 2017	
22	May 26, 2016			Dead	Portoscuso	CA		7L
23	August 4, 2016		1.34 (CCL)	Dead	Lampedusa	AG	Caracappa et al., 2017	
24	July 1, 2017			Live	Porto Caleri	RO	UNIPD (3)	
25	August 15, 2017			Live	Imperia	IM		8L
26	September 11, 2017	F	1.29 (CCL)	Dead	Genova	GE	CSC170911TDc1 (2)	
27	September 12, 2017			Dead	Lido di Venezia	VE	UNIPD (3)	

28	13 September 2017		2.50 (TOT)	Live	Teulada	CA		9L
29	November 10, 2017			Live	Cervia	RA		10L
30	June 18, 2018			Dead	Tindari-Milazzo	ME		
31	July 14, 2018		>0.70	Live	Laguna Venezia	VE	EuroTurtles.eu	12L
32	July 25, 2018			Live	Ischia	NA		13L
33	September 16, 2018			Live	Lampedusa	AG	EuroTurtles.eu	14L
34	September 23, 2018	ND	1.73 (CCL)	Dead	Loano	SV	CSC180923TDc1 (2)	
35	January 11, 2019	ND	1.08 (TOT)	Dead	San Felice Circeo	LT	CSC190111TDc1 (2)	
36	August 20, 2019			Live	San Nicola Arcella	CS		15L
37	October 22, 2019	F	1.40 (CCL)	Live	Ravenna	RA		16L
38	September 11, 2021			Live	Piombino	LI		17L
39	September 29, 2021			Live	Santo Stefano al mare	IM		18L
40	February 13, 2022			Dead	Scopello	TP		19L
41	August 10, 2022			Dead	Portofino	GE		20L
42	April 27, 2023			Live	Palinuro (1)	SA		21L
43	May 14, 2023			Live	Praia a Mare (1)	CS		22L
44	July 4, 2023			Live	Taranto	TA		23L
45	August 2, 2023			Live	Ravenna	RA		24L

Table 1. Records of Leatherback sea turtles in Italian Seas; (1) it is the same individual observed in two different dates and locations; (2) abbreviation of the card on the website Geocetus.it; (3) record estrapolated from the site chioggia.biologia.unipd.it of the University of Padua; (4) the turtle was given a plate number CH6526.

duce the number of duplicates and to identify the original photographic source, we applied the Tineye reverse image search application (https://tineye.com). We then supplemented our morphic searches via manual searches from different naturalistic and social media sites, Facebook (https://www.facebook.com/) and Twitter (https://twitter.com/) (see references). As for Facebook, the research was conducted within the following groups: Fauna Siciliana; Caretta Calabria Conservation; Torre Salsa Caretta; Luna Blu Diving Center, Castellammare; A.F.N.I. Associazione Fotografi Naturalisti Italiani (Italian Nature Photography association), AFNI Sezione Sicilia; Monitoraggio Tartarughe marine Sicilia orientale - Seaturtles SE Sicily; Centro di Educazione Ambientale ODV; Museo di Storia Naturale di Venezia; Oasi WWF Bosco Pantano; WWF Crotone. In addition, observations uploaded to platforms such as ornitho.it; INaturalist, GBIF.org, euroturtles.eu and Observation.org. These sites were not accessed via morphic tools, as they are not indexed by search engines (Leighton et al., 2016), but we decided to include them in our manual searches as they are very popular in the Italian naturalistic community. In order to make the observations shareable, most of these have been uploaded, as anonymous data, by the authors on the portal Ornitho.it.

N.	Date	Sex	Lenght (m)	Remarks	Localities	Province	Source	Sitography
1	August 1, 2009			Live	Porto Torres	SS	Corti et al., 2011	
2	September 22, 2009		29.5 CCL	Dead	Comacchio	FE	Vallini et al., 2014	
3	October 12, 2010		38.5 CCL	Live	Comacchio	FE	Vallini et al., 2014	
4	October 20, 2011	ND	33 CCL	Live	Cetraro	CS	CSC111020TCm1 (2)	
5	September 9, 2012	M	30 CCL	Dead	Venezia	VE	Garofalo et al., 2013	
6	March 24, 2014		50	Dead	Camaiore	LU	Mancusi, 2014 (1)	
7	August 24, 2014	ND	40 CCL	Dead	Silvi Marina	TE	CSC140824TCm1 (2)	
8	February 25, 2015			Live	Riccione	RN	FONDAZIONE CETACEA	
9	June 2, 2015		31 CCL	Dead	Margherita di Savoia	BT	Jancic et al., 2022	
10	August 3, 2015	ND	31	Dead	Zapponeta	FG		1G
11	August 14, 2015	ND	34 CCL	Live	Montebello Ionico	RC	CSC150814TCm1 (2)	
12	September 6, 2015			Live	San Benedetto del Tronto	AP	FONDAZIONE CETACEA	
13	February 22, 2016		30	Live	Avola	SR		2G
14	June 4, 2016	M	35 CCL	Dead	Isola di Capo Rizzuto	KR	CSC160604TCm1 (2)	
15	June 5, 2016	ND	25 CCL	Live	Melendugno	LE	CSC160605TCm1 (2)	
16	July 23, 2016	F	30 CCL	Dead	Termoli	CB	CSC160723TCm1 (2)	
17	October 9, 2016			Live	Scanzano Ionico	MT		3G
18	October 21, 2016	F	30 CCL	Dead	Taranto	TA	CSC150814TCm1 (2)	
19	October 26, 2016		30 CCL	Live	Trani	BT		4G
20	November 24, 2016		33 CCL	Live	Molfetta	BA		5G
21	January 23, 2017			Live	Numana	AN		6G
22	May 26, 2018	ND	120 CCL	Dead	Cagliari	CA	CSC180526TCm1 (2)	
23	August 28, 2018			Live	Scanzano Ionico	MT		7G
24	June 27, 2019		31 CCL	Dead	Rosignano Marittimo	LI	ARPAT, 2020	
25	July 5, 2019		35	Dead	Isola di Capo Rizzuto	KR		8G
26	August 28, 2019		33 CCL	Dead	Grosseto	GR	ARPAT, 2020	
27	September 14, 2019		64.5 CCL	Dead	Grosseto	GR	ARPAT, 2020	

28	May 29, 2020		48	Live	Arborea	OR		9G
29	June 16, 2020			Dead	Venezia	VE		10G
30	June 29, 2020			Live	Manfredonia	FG		11G
31	July 3, 2020			Live	Policoro	MT		12G
32	August 16, 2020	ND	31 CCL	Dead	Termoli	CB	CSC200816TCm1 (2)	
33	September 30, 2020	ND		Dead	Chioggia	VE	ORNITHO (3)	
34	December 3, 2020		49 CCL	Live	Bisceglie	BT		13G
35	January 23, 2021	ND		Dead	Sabaudia	LT	ORNITHO (4)	
36	March 21, 2021		35	Dead	Ravenna	RA		14G
37	May 14, 2021			Dead	Ugento	LE		15G
38	June 22, 2021	F	29 CCL	Dead	Montesilvano	PE	CSC210622TCm1 (2)	
39	July 5, 2021	F	29.5 CCL	Dead	Roseto degli Abruzzi	TE	CSC210705TCm1 (2)	
40	October 22, 2021			Dead	Molfetta	BA		16G
41	October 23, 2021			Live	Bisceglie	BT		17G
42	March 5, 2022		<30	Dead	Lido degli Scacchi	FE		18G
43	April 14, 2022			Live	Salve	LE		19G
44	May 28, 2022		27.8	Live	Castellaneta	TA		20G
45	July 17, 2022	ND	27	Dead	Vasto	CH	CSC220717TCm1 (2)	
46	October 7, 2022	ND	40 CCL	Dead	Civitavecchia	RM	CSC221007TCm1 (2)	
47	November 1, 2022			Dead	Venezia	VE		21G
48	February 17, 2023		20	Live	Melendugno	LE		22G
49	March 1, 2023			Dead	Otranto	LE	TARTAPEDIA	
50	March 4, 2023			Live	Otranto	LE		23G
51	August 4, 2023	ND		Dead	Jesolo	VE	ORNITHO (5)	
52	October 1, 2023			Dead	Latina	LT		24G
53	November 29, 2023			Live	Melendugno	LE		25G

Table 2. Records of Green turtles in Italian Seas; (1) specimen of difficult determination could be an aberrant Caretta (S. Vanni and N Novarini, pers. comm.); (2) abbreviation of the card on the website Geocetus.it; (3) observed by J. Kraft; (4) observed by G. Di Lieto & E. Ferrari; (5) observed by F. Muller.

RESULTS AND CONCLUSIONS

Citizen Science (CS) is now a reality. With increasing attention to biodiversity, more and more people are talking about nature. The criticalities inherent in the CS (Surdo & Massa, 2020) have not been found for these species that lend themselves perfectly to the widespread collection of data. Sea turtles have the attention of all media from local newspapers and TV. Unfortunately, the many records are scattered in a plethora of sites, facebook groups, platforms that make it really difficult to collect. An effort is now needed to try to synthesize all these scattered data on the web and make them available through a scientific publication (Casale et al., 2018).

The purpose of this work is to provide background data on abundances and distribution of the Leatherback sea turtle since 2002 (Casale, 2003) and Green turtle since 2009 (Bentivegna et al., 2011) found in the waters around the Italian peninsula and islands (Figs. 2, 3).

Due to our new findings within the past twenty-two years, the number of leatherback

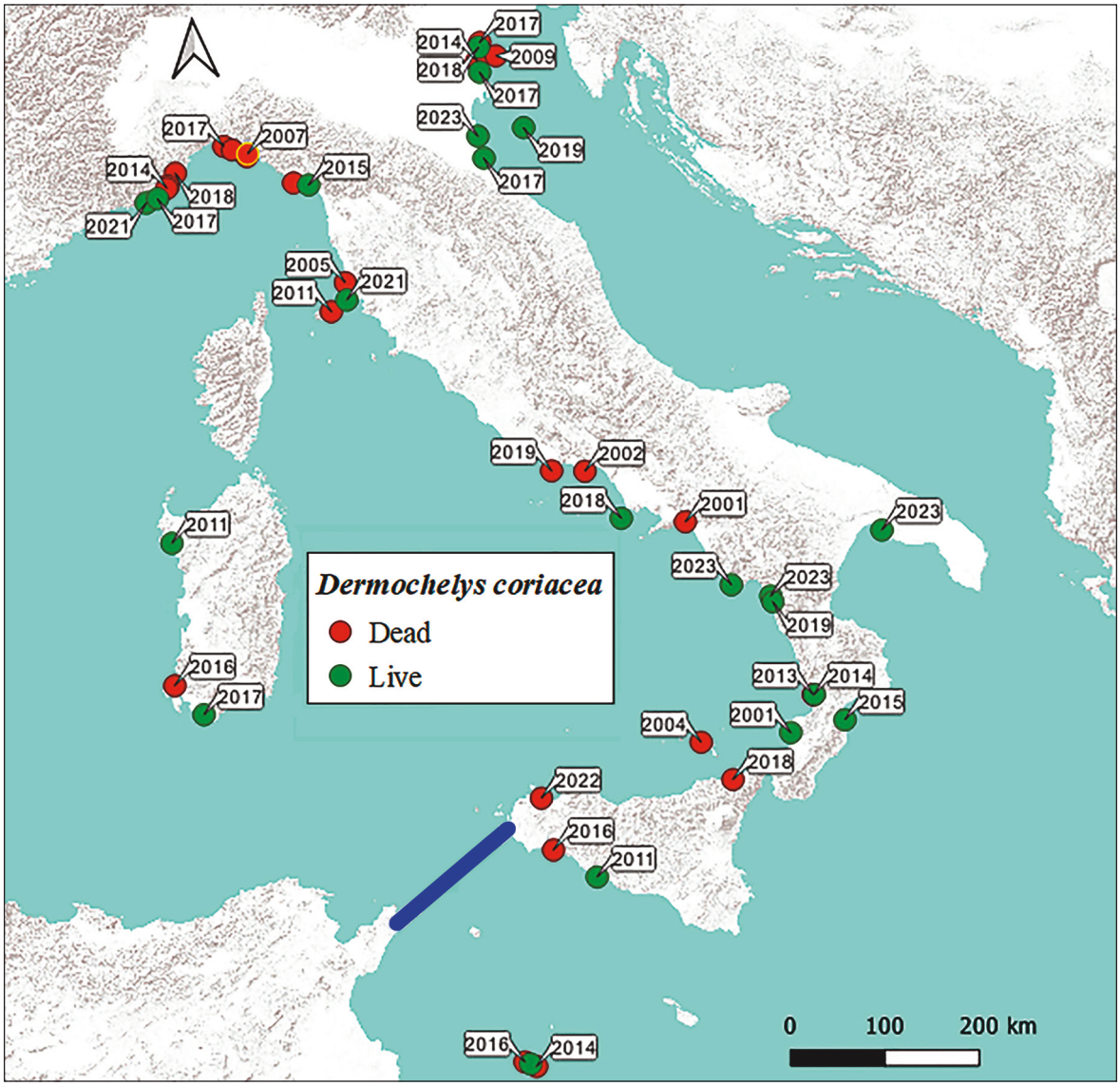


Figure 2. Locality records of the Leatherback sea turtles, *Dermochelys coriacea*, in Italy (n=45). Blue line: division between western and eastern basins.

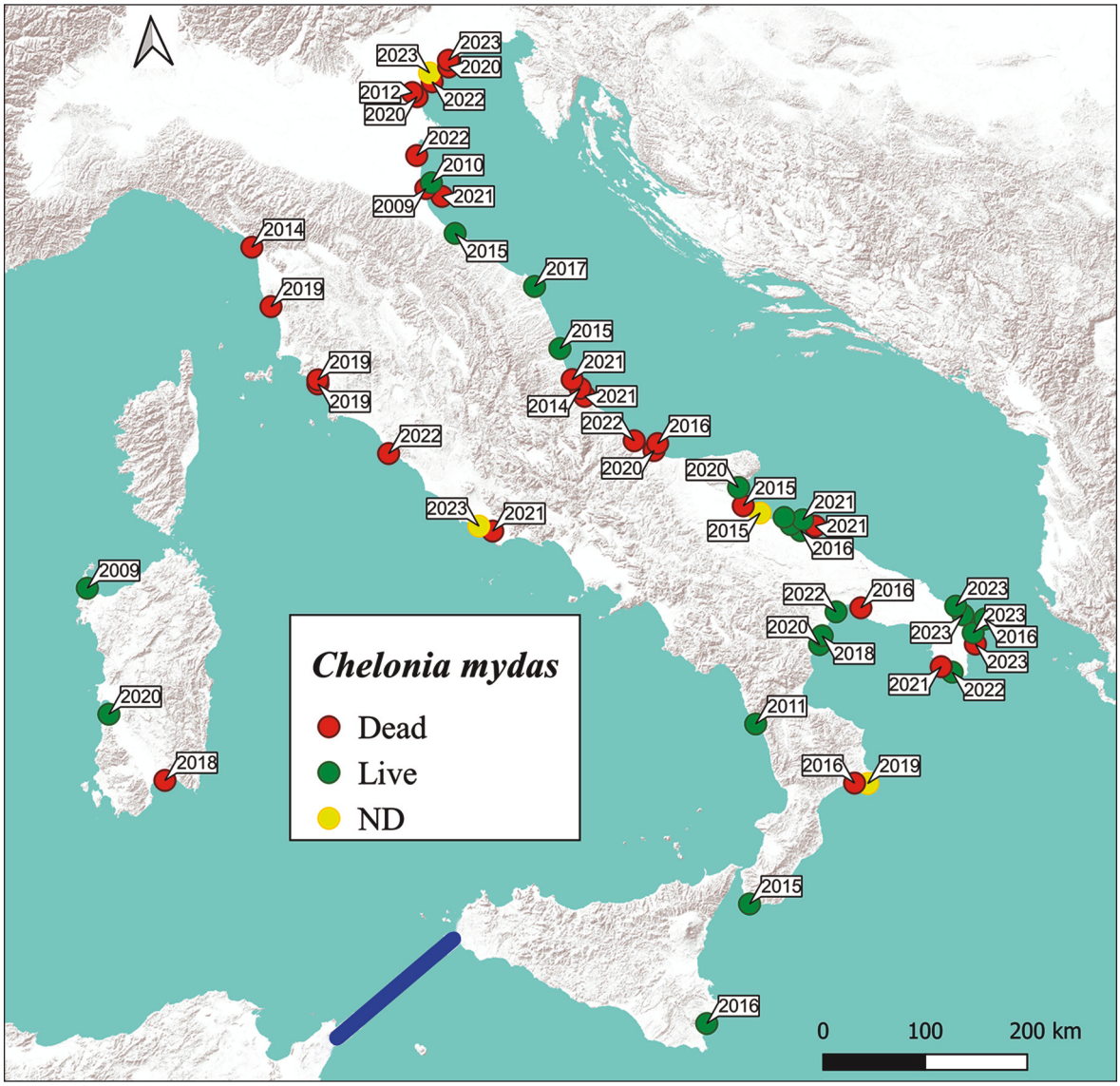


Figure 3. Geographical distribution of Italian Green turtles, *Chelonia mydas*, records (n=53). Blue line: division between western and eastern basins.

records in Italy has increased. However, this increase should probably not be attributed to an increased number of turtles frequenting these waters. It is most likely a result of the recent systematic collection of data on sea turtles and increased public awareness due to educational campaigns carried out in Italy.

In the western basin we have more observations of Leatherback sea turtle but seasonal differences between western and eastern basins do not seem to occur (χ^2=8.11, df=3, P=0.04, *n*=45), suggesting the lack of strong seasonal movements between them (Fig. 4). Since it is assumed that specimens originate in the Atlantic, this also suggests that the species is present in the Mediterranean Sea all the year round, without an evident seasonal migration pattern. Size distribution of Leatherback sea turtles of the Italian Seas (n=13) is reported in Figs. 5, 6.

Unfortunately (Fig. 7) 56 % of the turtles observed in Italy, reported in this study, were found dead or died shortly after recovery.

The majority of Mediterranean leatherback records derived from incidental captures in fish-

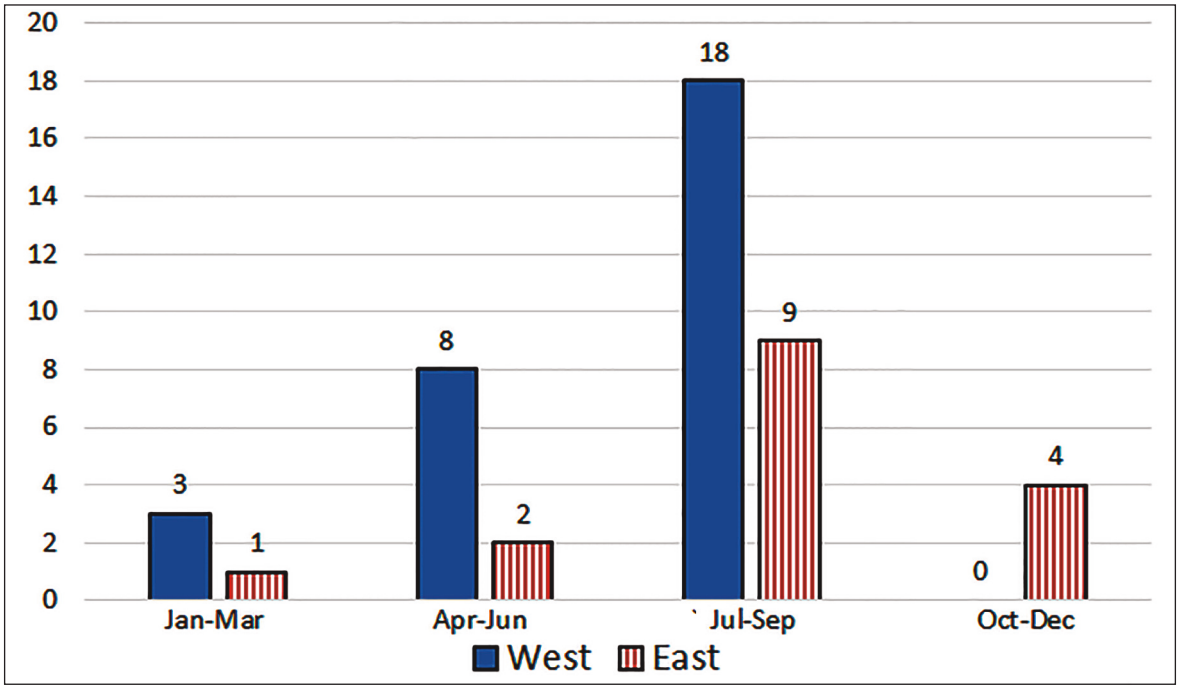
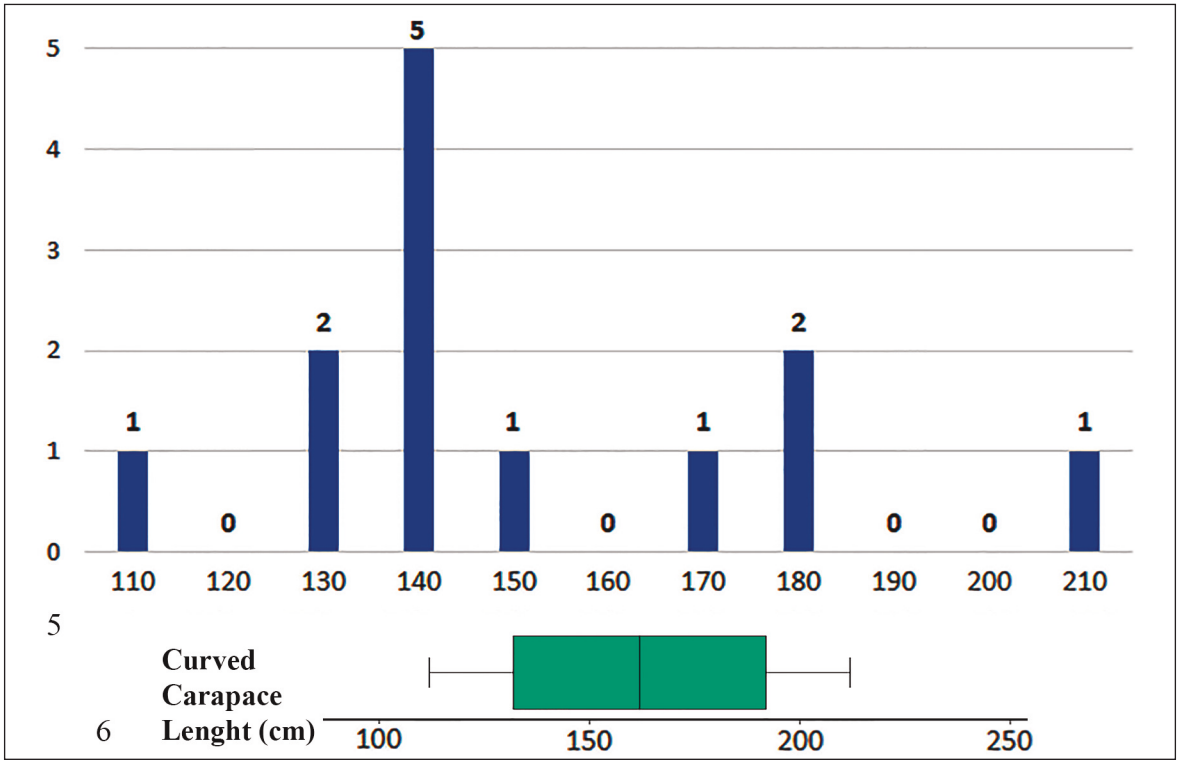


Figure 4. Temporal distribution of observations of Leatherback sea turtles records (n=45) in the western and eastern basins.



Figures 5, 6. Size distribution of Leatherback sea turtles in Italian Seas (n=13). Fig. 5: frequency histogram with 10 cm length classes. Fig. 2: boxplot with the box representing values between 25th and 75th percentile and whiskers extending to a maximum of 1.5 times inter-quantile range.

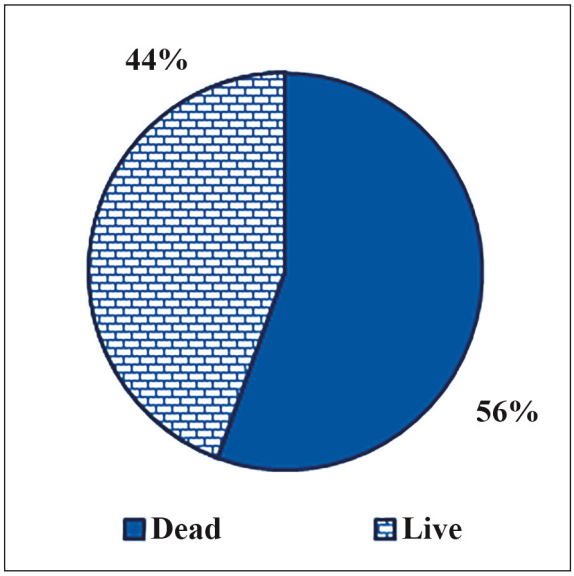


Figure 7. Frequency of observations of dead, living or unidentified specimens (n= 45) of Leatherback turtles.

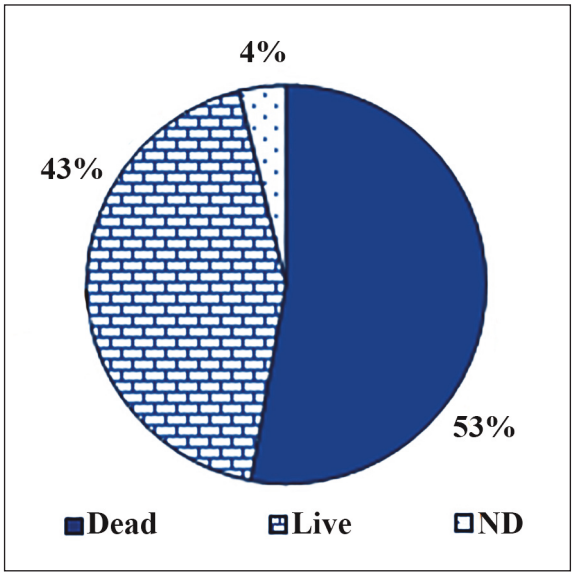


Figure 9. Frequency of observations of dead, living or unidentified specimens (n= 53) of Green turtles.

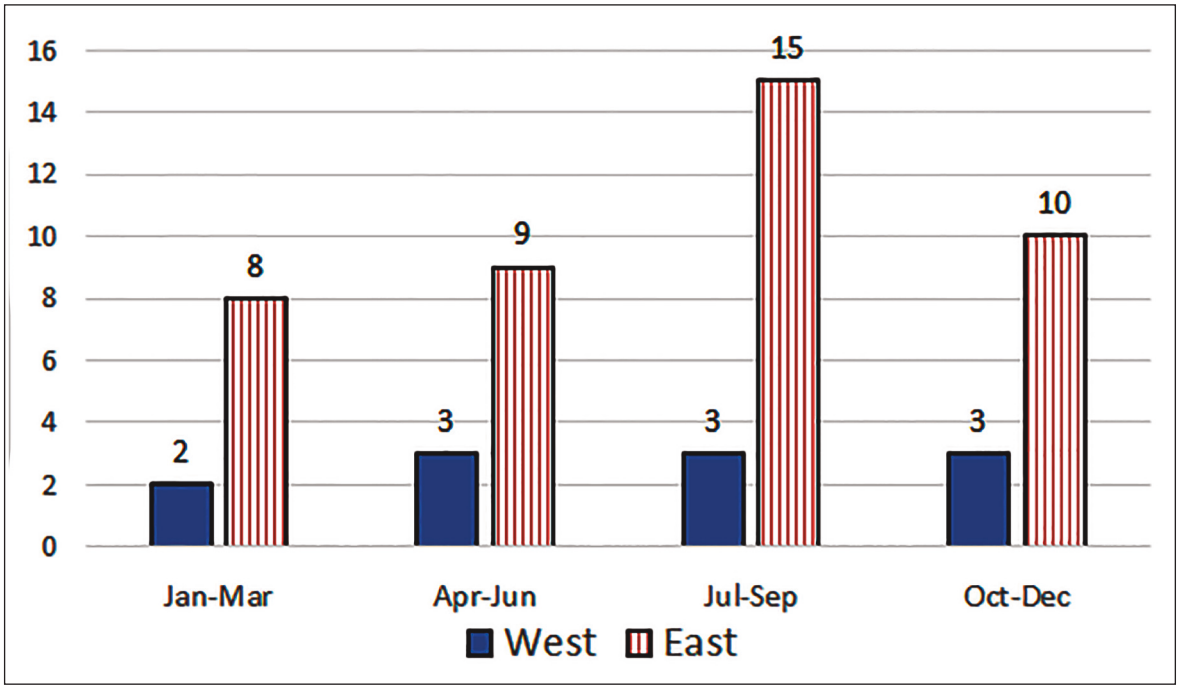
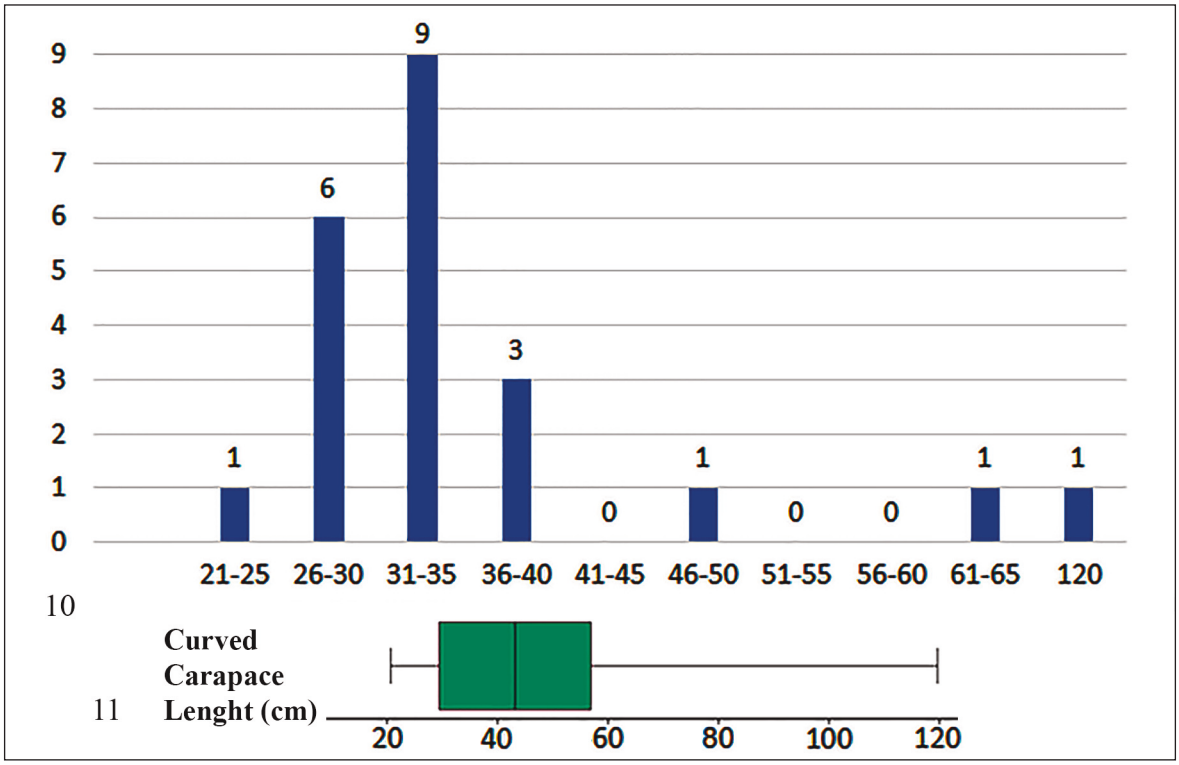


Figure 8. Temporal distribution of observations (n=53) of Green turtles in the western and eastern basins.

eries, principally with the set drift gillnets, resulting in considerable mortality (at least 36 %, Casale et al., 2003). Casale et al. (2003) also considered that by-catches in Mediterranean fisheries have a negligible impact on the population in view of the low catch per unit of effort (CPUE) in the Mediterranean compared to the Atlantic. In contrast, Lewison et al. (2004) estimated that the number of Leatherbacks caught in longline fisheries in the Mediterranean may range from 250 to 10,000 an-



Figures 10, 11. Size distribution of green sea turtles in Italian seas (n=31). Fig. 10: frequency histogram with 5 cm length classes. Fig. 11: boxplot with the box representing values between 25th and 75th percentile and whiskers extending to a maximum of 1.5 times inter-quantile range.

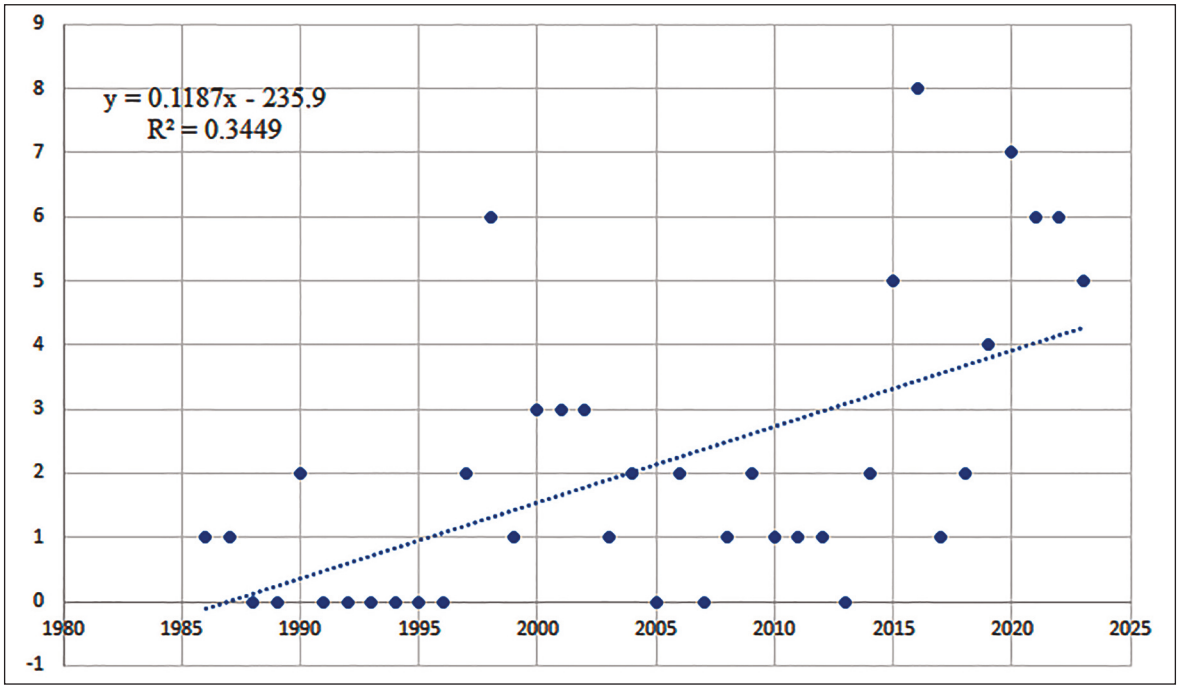


Figure 12. Trend of Green turtle observations (n=79) from 1986 to 2023 (Bentivegna et al., 2011; present study). Regression line values are shown on the graph.

nually. Although the Atlantic rookeries as natal nesting grounds of Mediterranean migrants are reported to be stable or even increasing (Hughes, 1996; Chevalier & Girondot, 2000; Dutton et al., 2000; 2005), and despite the low CPUE, the problem of leatherback bycatch in the Mediterranean should not be ignored, for two reasons:

1. It is still unclear to which natal population (or populations) these leatherbacks belong. If they originate from a single nesting population, the impact of fisheries in the Mediterranean may still be an issue for conservation, depending on the population size and trend.

2. It targets large immatures and adults, the size-classes with the highest reproductive potential (Lazar et al., 2008).

In the eastern Mediterranean Sea we have more observations of Green turtle but seasonal differences between western and eastern basins do not seem to occur (χ^2=0,36, df=3, P=0.95, *n*=53), suggesting the lack of strong seasonal movements between them (Fig. 8).

Also for Green turtle (Fig. 9), 53% of the turtles observed in Italy and reported in this study, were found dead or died shortly after recovery.

The size distribution of green turtles in Italy (Fig. 10, 11) corresponds to the size of turtles found in neritic foraging areas in Greece (Margaritoulis & Teneketzis, 2003).

As for the Green Turtle, it can be assumed that the greater presence of youngs in the Italian seas (Fig. 12) is the direct consequence of the increase of the population of Mediterranean green turtles (Stokes et al., 2014; Casale et al., 2018). Another reason for the increased observations of this species may be due to the rise in sea water temperature.

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