

First report of a great white shark in the waters of the Port-Cros National Park (France, northwestern Mediterranean Sea)

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Abstract. We report the sighting of a 350-400 cm total length great white shark, *Carcharodon carcharias* close to Gros Sarranier Islet, at the eastern end of the Porquerolles Archipelago, in the core area of the Port-Cros National Park (France, northwestern Mediterranean Sea), on 17th November 2024. This species, which has severely declined worldwide, is considered as critically endangered in the Mediterranean Sea.

Keywords: *Carcharodon carcharias*, critically endangered species, Port-Cros National Park.

Résumé. Première signalisation d'un grand requin blanc dans les eaux du Parc national de Port-Cros (France, Méditerranée nord-occidentale). Un grand requin blanc *Carcharodon carcharias* de 350-400 cm de longueur totale a été observé près de l'îlot du Gros Sarranier, à l'extrémité Est de l'île de Porquerolles, en zone cœur du Parc national de Port-Cros (France, nord-ouest de la mer Méditerranée), le 17 novembre 2024. Cette espèce, dont le déclin a été sévère à l'échelle mondiale, est considérée comme en danger critique en Méditerranée.

Mots-clés: *Carcharodon carcharias*, espèce en danger critique, Parc national de Port-Cros.

Introduction

The great white shark *Carcharodon carcharias* (Linnaeus, 1758) can be found in coastal surface waters of all the major oceans and seas, including the Mediterranean Sea (De Maddalena and Révelart, 2008; De Maddalena and Zuffa, 2009; De Maddalena, 2017). The maximum total length (TL) is 6.0-7.0 m (De Maddalena *et al.*, 2003; De Maddalena and Révelart, 2008). It is a long-lived species: age at maturity is 26 and 33 years for males and females, respectively, and some female individuals could reach an age of over 70 years (Natanson and Skomal, 2015).

In the Mediterranean, the great white shark feeds on large fish such as tuna (*Thunnus* spp.) and swordfish *Xiphias gladius* Linnaeus, 1758, delphinids such as the common dolphin *Delphinus delphis* Linnaeus, 1758, *Tursiops truncatus* (Montagu, 1821) and *Stenella coeruleoalba* Meyen, 1833, seals and the loggerhead sea turtle *Caretta caretta* (Linnaeus, 1758) (Ody *et al.*, 2016; Boldrocchi

et al., 2017; Olaya-Penzone *et al.*, 2020; Bompar *et al.*, 2021). It also used to prey on the monk seal *Monachus monachus*) Hermann, 1779 when the species was common (De Maddalena and Heim, 2012; Boldrocchi *et al.*, 2017). In contrast, despite some cases of humans being bitten, great white sharks do not target humans, which are too bony and not fat enough for their liking; however, they routinely investigate novel objects as potential prey by biting them (Clua and Meyer, 2023).

Here, we report the opportunistic sighting of a great white shark at the eastern end of the Porquerolles Archipelago, in the core area of the Port-Cros National Park (PCNP) (Provence, France, northwestern Mediterranean).

Results

On 17th November 2024 at 10:30 AM (local time LT, UTC+2), a great white shark, *Carcharodon carcharias* was observed near the eastern part of Porquerolles Archipelago, close to Gros Sarranier Islet (**Fig. 1**). The species identification follows Ebert and Dando (2020) and Barone *et al.* (2022) as identification keys for the lamnid sharks. Stout, spindle-shaped body. Long conical snout. A lamnid shark species with small dark black round eyes compared with the other Mediterranean lamnid species of the genera (*Isurus*) and (*Lamna*). Massive, fusiform body with a dark grey dorsal coloration, interspersed with shades of brown, sharply contrasting with its marked white belly. The pectoral fins are large and curved. Long gill slits all in front of the beginning of the pectoral fins. The fifth gill slit is slightly longer and oblique. The first dorsal fin is large, triangular, and curved backward. Its posterior margin is clearly concave. Minute second dorsal fin (from Ebert and Dando, 2020: 278-284; Barone *et al.*, 2022, in Chapter 'Large pelagics, Lamniformes, Lamnidae: 13).

The observer, one of the co-authors (LD), was snorkelling during an outing of a freediving club. The activity was carried out in compliance with the regulations in force in France (articles A 322-78 and A 322-81 of the *Code du sport relative aux activités subaquatiques*). The observer was snorkelling at a depth of 27 m over a mixed seabed composed of *Posidonia oceanica* (Linnaeus) Delile seagrass meadows and rocky reefs. Several dusky groupers, *Epinephelus marginatus* (Lowe, 1834) were observed dwelling in the area. While returning to the surface, LD initially mistook the shark for a boat moored near his inflatable boat but quickly realized it was a great white shark. He was able to observe the specimen close up.

The shark was estimated to be approximately 3.5-4.0 m in total length (TL). LD noted the absence of claspers, suggesting it might be a female.

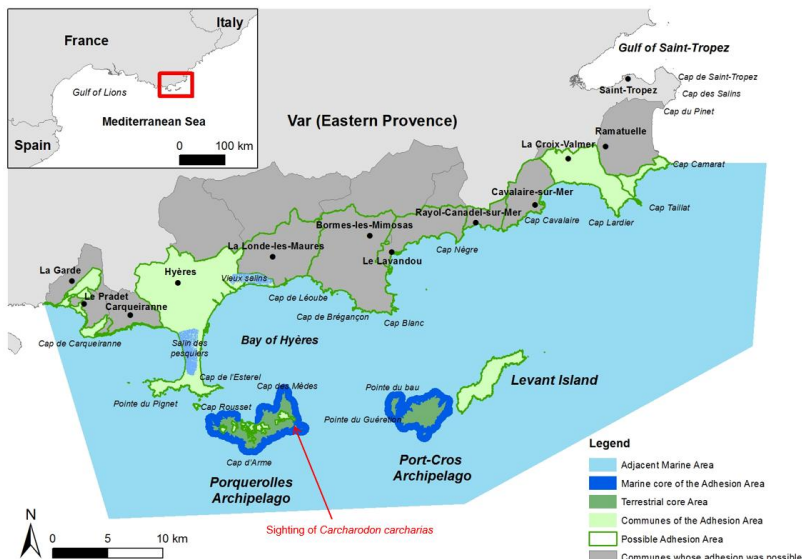


Figure 1. Location of the great white shark *Carcharodon carcharias* sighted on 17th November 2024 at Porquerolles Archipelago (Port-Cros National Park – PCNP) (France, NW Mediterranean).

No trace of postcopulatory bites was visible on the body of this shark, despite an injury on the left side of the head. According to the estimated TL of the individual, it is difficult to attest whether the sighted shark was an adult or a subadult (Fergusson, 1996; Natanson and Skomal, 2015; Boldrocchi *et al.*, 2017; Ebert and Dando, 2021). Video footage of the shark was also captured by others present during the encounter. Another member of the team even entered the water to swim with the shark, which exhibited calm and non-aggressive behaviour, swimming slowly and accompanied by a group of pilot fish *Naucrates ductor* (Linnaeus, 1758).

Discussion

To date, this observation is the best-documented, the 23rd in the French *Région Sud* (Provence-Alpes-Côte d'Azur), which extends from Marseilles to Nice (**Table 1, Fig. 2**), and the 50th within the Gulf of Lions since the Middle Ages; overall, 794 specimens have been recorded within the whole of the Mediterranean Sea since 1600 CE (De Maddalena and Zuffa, 2009; De Maddalena and Heim, 2012; Boldrocchi *et al.*, 2017; Kabasakal and Bayri, 2021; Kabasakal *et al.*, 2022; Deysson *et al.*, 2024; Soldo and Bakiu, 2024).

Table 1. Historical occurrence of *Carcharodon carcharias* from the Middle Ages to the present day in waters of the French *Région Sud* (Provence-Alpes-Côte d'Azur) (NW Mediterranean). The information is reported as provided by the authors, even when it should be treated with caution; for example, Aix-en-Provence is an inland city; knights in armour in a shark's stomach are hardly credible. TL: total length; CE: Common Era; F: female; M: male.

N°	Date (year CE)	Location	TL (cm)	Mass (kg)	Sex	Age class	Comments	References
1	Middle Age 476 - 1453	Aix-en-Provence	670	-	-	Adult	Bycatch: knight in armour in the stomach	De Maddalena and Heim (2012)
2	04/1554	Nice	-	-	-	-	Bycatch: knight in armour in the stomach	De Maddalena and Heim (2012)
3	04/1554	Marseille	-	-	-	-	Bycatch: knight in armour in the stomach	De Maddalena and Heim (2012)
4	18th century	Between Cassis and La Ciotat	-	-	-	-	Bycatch: dead human and 2 bluefin tunas in the stomach	De Maddalena and Heim (2012)
5	1889	La Seyne-sur-Mer	-	-	-	-	Bycatch: 4 teeth, MNHN Paris (cat. No. MNHN ab-0185).	De Maddalena and Heim (2012)
6	10/1889	Le Brusc, Six-Fours-les-Plages	400	-	-	-	Bycatch: common porpoise <i>Phocoena phocoena</i> and human remains in the stomach	De Maddalena and Heim (2012)
7	04/1893	Toulon	-	-	-	-	-	De Maddalena and Heim (2012)
8	04/1898	Var	550	2 000	-	Adult	Bycatch: common porpoise <i>Phocoena phocoena</i> , 3 bluefin tunas and other fishes in the stomach	De Maddalena and Heim (2012)
9	04/1909	Camargue	-	-	-	-	Bycatch: dried jaws Musée Océanographique de Monaco (cat. No. MOM-P01-4254).	De Maddalena and Heim (2012)
10	04/1909	Maritimes	-	-	-	-	Bycatch: Dried jaws Musée Océanographique de Monaco (cat. No. MOM-P01-4253).	De Maddalena and Heim (2012)
11	15/10/1925	L'Estaque, Marseille	>600	1 500	F	Adult	Bycatch	De Maddalena and Heim (2012)

N°	Date (year CE)	Location	TL (cm)	Mass (kg)	Sex	Age class	Comments	References
12	04/09/1926	Le Brusç, Six-Fours-les-Plages	450	-	-	Adult	Bycatch by trammelnet	Deysson <i>et al.</i> (2024)
13	1930	Le Brusç, Six-Fours-les-Plages	464-480	-	-	Adult	Bycatch by trammelnet: Dried jaws	Deysson <i>et al.</i> (2024)
14	1954	Le Brusç, Six-Fours-les-Plages	400		M	Adult	Bycatch by trammelnet	Deysson <i>et al.</i> (2024)
		Calanques of Nîlon (Le Rove) and Figuerolles (La Ciotat)	-	1 800	-	-	Bycatch: a whole monk seal <i>Monachus monachus</i> , dolphin and bluefin tuna remains in the stomach	De Maddalena and Heim (2012)
15	1956	Tiboulén, Frioul Islands, Marseille	500-600	-	-	Adult	Divers' sighting, <i>Marins Pompiers de Marseille</i>	De Maddalena and Heim (2012)
16	04/12/1986		>400	-	-	Adult	Live individual sighted hunting tuna	De Maddalena and Heim (2012)
17	1989	Marseille	-	-	-	-	Bycatch by sportfishermen	De Maddalena and Heim (2012)
18	1993	Between Nice and Corsica	-	-	-	-		
19	06/10/2001	Between Cap Croisette and Cap Caveaux, Marseille	630-680	-	-	Adult	Sighting by divers on the Miquelon shipwreck	De Maddalena and Heim (2012)
20	20/06/2002	Causinière, Cap Ferrat, Saint-Jean-Cap-ferrat	400	-	-	-	Sighting of a live shark by divers	De Maddalena and Heim (2012)
		Between Toulon (mainland France) and Sagone (Corsica)	600	-	-	Adult	Sighting of a live shark 90 km offshore during 45 minutes	De Maddalena and Heim (2012)
21	12/2009		>500	-	F	Adult	Sighting of a live individual 9 km off the coast of the Camargue Regional Natural Park	Nicolas Ziani, GPER (unpublished observation)
22	22/09/2022	Camargue	350-400	-	F	Subadult or adult?	Sighting of a live shark 300 m off the coast of the Porquerolles Island (Port Cros National Park)	This study
23	17/11/2024	Porquerolles Island, Hyères						

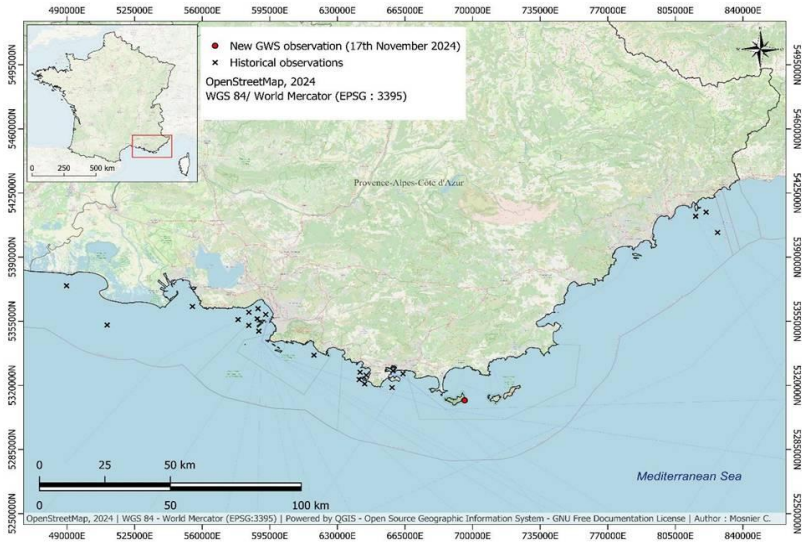


Figure 2. Map of sightings of *Carcharodon carcharias* from the Middle Ages to the present day in waters of the French *Région Sud* (Provence-Alpes-Côte d'Azur) (NW Mediterranean) (see Table 1). GWS: great white shark.

The great white shark was relatively abundant in the Mediterranean in Antiquity and the Middle Ages, at a time when it was little or not hunted by humans and when some of its prey (large fish, seals) were more abundant; today, it is in severe decline (De Maddalena, 2017). It is now threatened worldwide and is assessed by the IUCN (International Union for Conservation of Nature) as vulnerable (VU) globally and critically endangered (CR) in Europe and in the Mediterranean (Soldo *et al.*, 2016; Ferretti *et al.*, 2024). It has been listed in the Annexes of the Barcelona Convention since 1996, in those of the Bern Convention since 1997 (for the Mediterranean) and in Appendix II of the Washington Convention (CITES). Finally, it is prohibited for European Union (EU) vessels to fish for, to retain on board, to tranship or to land *Carcharodon carcharias* (European Union, 2017). *Carcharodon carcharias* is not the only endangered shark in the Mediterranean: most species have declined by more than 96%, and up to 99%, since the 1800s (Ferretti *et al.*, 2008; Moro *et al.*, 2020).

At a large scale, the northwestern Mediterranean is among the richest zones of the Mediterranean Sea. During harsh winters deep convection occurs offshore the Gulf of Lions and between Corsica and Provence. The deep mixing induced replenishes the surface

layer with nutrients, hence sustaining intense spring phytoplankton blooms (Monaco *et al.*, 2009; Stambler, 2014; Testor *et al.*, 2018; Schroeder *et al.*, 2023). These blooms give rise zooplankton blooms, including krill, foraged by animals ranging from bluefin tuna juveniles to fin whales. During summertime (stratified period) the mesoscale dynamic activity (e.g. eddies, filaments) takes over to sustain production (Cotté *et al.*, 2009). When summer is exceptionally windy (Mistral) mixing in the central area between Corsica and Provence replenishes the surface layer with nutrients and supports a secondary phytoplankton bloom (Taupier-Letage *et al.*, 2013).

At a smaller scale Port-Cros and Porquerolles islands are located on the northern rim of the Northern Current. The instability of the Northern Current during wintertime and episodes of upwelling during summertime (Taupier-Letage *et al.*, 2013) give rise to the mesoscale dynamics prone to enhancing production.

The Archipelagos of Port-Cros and Porquerolles constitute the core area of the PCNP. In this area, the health and diversity of coastal ecosystems (e.g. seagrass meadows, rocky reefs, coralligenous, coastal detritic bottoms) enhance the entire food web (Astruch *et al.*, 2012; Personnic *et al.*, 2014; Astruch *et al.*, 2018; Boudouresque *et al.*, 2020, 2021; Cheminée *et al.*, 2021; Astruch *et al.*, 2023; Jacob *et al.*, 2024). Although the presence of the great white shark sighted within the core marine area of the PCNP may be explained by foraging behaviour, as large dusky groupers (*Epinephelus marginatus*) were present near the sea bottom, a real reserve effect is unlikely for this shark: they travel widely over hundreds or thousands of kilometres (Bruce *et al.*, 2006; Skomal *et al.*, 2017), and the tiny core areas of the PCNP (less than 10 km wide each) cannot be significant in terms of their foraging behaviour.

The late-summer and the autumn are the seasons of peak occurrence of *C. carcharias* in the Northwestern Mediterranean, especially to forage on bluefin tunas (Boldrocchi *et al.*, 2017; Carpaye-Tailamée and Maurel, 2023). The abundance of bluefin tuna is also higher in the *Région Sud* than in Occitania region of the eastern and western Gulf of Lions, respectively (Farrugio, 2013), although this may have changed since the date of the Farrugio's report, in relation with changes in the fishing effort and the absence of deep convection (Bănaru *et al.*, 2013). There is a clear correlation between tuna availability and the historical occurrence of *C. carcharias* in the *Région Sud* (De Maddalena and Zuffa, 2009; Boldrocchi *et al.*, 2017).

Conclusions

The sighting we report represents the first documented presence of a great white shark within the PCNP. This is a result of citizen science, a key tool to enrich international in-depth studies on the Mediterranean *C. carcharias* population (Jambura *et al.*, 2021).

There is an urgent need to better understand the life history of the great white shark, the largest non-mammal predator in the Mediterranean, and to improve the collective research effort over the whole of the Mediterranean for its conservation, as a critically endangered species on the IUCN Red List. Presented as a terrifying monster in the well-known Spielberg film ('Jaws'), the great white shark is now gaining in popularity and its protection is beginning to be more widely accepted (Boero, 2017). Although much less dangerous than generally imagined, we do not recommend swimming with it, as it is a wild animal and as such its behaviour is unpredictable.

Acknowledgements. The co-authors are grateful for the contribution of Emmanuel Baffil, Plymouth University, UK and Rémi Bru, Aix-Marseille University, a volunteer research student in the GPER, Marseille, France. They also thank Michael Paul, a native English speaker, for proofreading the manuscript, together with two reviewers (Sébastien Biton and Isabelle Taupier-Letage), who greatly improved the manuscript. The PCNP thanks M. Lapinsky from the Association Ailerons for reporting the shark sighting to the PCNP agents.

References

- ASTRUCH P., BOUDOURESQUE C.F., BONHOMME D., GOJJARD A., ANTONIOLI P.A., BONHOMME P., PEREZ T., RUITTON S., SAINT-MARTIN T. de, VERLAQUE M., 2012. Mapping and state of conservation of benthic marine habitats and assemblages of Port-Cros national Park (Provence, France, northwestern Mediterranean Sea). *Sci. Rep. Port-Cros Natl. Park*, 26: 45-90.
- ASTRUCH P., BOUDOURESQUE C.F., ROUANET É., LE DIRÉACH L., BONHOMME P., BONHOMME D., GOJJARD A., RUITTON S., HARMELIN J.G., 2018. A quantitative and functional assessment of fish assemblages of the Port-Cros Archipelago (Port-Cros National Park, north-western Mediterranean Sea). *Sci. Rep. Port-Cros Natl. Park*, 32: 17-82.
- ASTRUCH P., ORTS A., SCHOHN T., BELLONI B., BALLESTEROS E., BĂNARU D., BIANCHI C.N., BOUDOURESQUE C.F., CHANGEUX T., CHEVALDONNÉ P., HARMELIN J.G., MICHEZ N., MONNIER B., MORRI C., RUITTON S., THIBAUT T., VACELET J., VERLAQUE M., DANIEL B., 2023. Ecosystem-based assessment of a widespread Mediterranean marine habitat: the Coastal Detrital Bottoms, with a special focus on epibenthic assemblages. *Front. Mar. Sci.*, 10 (1130540): 1-25.
- BĂNARU D., MELLON-DUVAL C., ROOS D., BIGOT J.L., SOUPLET A., JADAUD A., BEAUBRUN P., FROMENTIN J.M., 2013. Trophic structure in the Gulf of Lions marine ecosystem (north-western Mediterranean Sea) and fishing impacts. *J. Mar. Syst.*, 111-112: 45-68.
- BARONE M., MAZZOLDI C., SERENA F., 2022. *Sharks, rays and chimaeras in Mediterranean and Black Seas. Key to identification*. FAO publ., Rome: 1-96.
- BOERO F., 2017. From Marine Protected Areas to MPA networks. In: *Management of Marine Protected Areas: a network perspective. First edition*. Goriup P.D. (Ed.), John Wiley & Sons Ltd. publ.: 1-20.
- BOLDROCCHI G., KISKA J., PURKIS S., STORAI T., ZINZULA L., BURKHOLDER D., 2017. Distribution, ecology, and status of the white shark, *Carcharodon carcharias*, in the Mediterranean Sea. *Rev. Fish Biol. Fisheries.*, 27 (3): 515-534.
- BOMPAR J.M., RATEL M., ODY D., BOUDOURESQUE C.F., 2021. *Les cétacés: peuplement de Méditerranée, écologie, statuts de conservation et comportements*. Muraceti publ., La Couronne, Martigues, France: 1-69.

- BOUDOURESQUE C.F., MÉDAIL F., PONEL P., ASTRUCH P., BARCELO A., BLANFUNÉ A., CHANGEUX T., CHEVALDONNÉ P., CHEYLLAN G., LE DIRÉACH L., MARTIN G.J., MOUSSAY C., PEYRACHE M., PERRET-BOUDOURESQUE M., RUITTON S., TAUPIER-LETAGE I., THIBAUT T., 2020. Species-based or ecosystem-based approaches to conservation practices: lessons from the Port-Cros National Park (South-east France, Mediterranean Sea). *Vie Milieu / Life & Environ.*, 70 (3-4): 89-112.
- BOUDOURESQUE C.F., BARCELO A., BLANFUNÉ A., CHANGEUX T., MARTIN G., MÉDAIL F., PERRET-BOUDOURESQUE M., PONEL P. ; RUITTON S., TAUPIER-LETAGE I., THIBAUT T., 2021. Biodiversity management in a Mediterranean national park: The long, winding path from a species-centred to an ecosystem-centred approach. *Diversity*, 13 (594): 1-30.
- BRUCE B.D., STEVENS J.D., MALCOLM H., 2006. Movements and swimming behaviour of white sharks (*Carcharodon carcharias*) in Australian waters. *Mar. Biol.*, 150: 161-172.
- CARPAYE-TAILAMÉE T., MAUREL M., 2023. Perspective on great white sharks (*Carcharodon carcharias*) in the northwestern Mediterranean and recommendations for further field research. *Ann. Ser. Hist. Nat.*; Kopper, 33 (2): 151-164.
- CHEMINÉE A., LE DIRÉACH L., ROUANET É., ASTRUCH P., GOJJARD A., BLANFUNÉ A., BONHOMME D., CHASSAING L., JOUVENEL J.Y., RUITTON S., THIBAUT T., HARMELIN M., 2021. All shallow coastal habitats matter as nurseries for Mediterranean juvenile fish. *Sci. Rep.*, 11 (14631).
- CLUA E.E.G., MEYER C.G., 2023. The 'Mistaken Identity Hypothesis' for shark bites on humans is an anthropomorphic fallacy. *Behaviour*, 160: 1153-1165.
- COTTÉ C., D'OVIDIO F., CHAIGNEAU A., LEVY M., TAUPIER-LETAGE I., MATE B., GUINET C., 2009. Scale-dependent interactions of resident Mediterranean whales with marine dynamics. *Limnol. Oceanogr.*, 56: 219-232.
- DE MADDALENA A., 2017. *Requins de Méditerranée. Histoires et études de 50 espèces*. Turtle Prod éditions, Hyères: 1-256.
- DE MADDALENA A., HEIM W., 2012. *Mediterranean great white sharks: a comprehensive study including all recorded sightings*. McFarland & Company publ., Jefferson, North Carolina, USA: 1-256.
- DE MADDALENA A., RÉVELART A.L., 2008. *Le grand requin blanc sur les côtes françaises. Observations et captures*. Turtle Prod éditions, Hyères, France: 1-83.
- DE MADDALENA, ZUFFA M., 2009. Historical and contemporary presence of the great white shark, *Carcharodon carcharias* (Linnaeus, 1758), along the Mediterranean coast of France. *Boll. Mus. Civico Storia Nat. Venezia*, 59: 81-94.
- DE MADDALENA A., GLAIZOT O., OLIVER G., 2003. On the great white shark, *Carcharodon carcharias* (Linnaeus, 1758), preserved in the Museum of Zoology in Lausanne". *Marine Life*. 13 (1-2): 53-59
- DEYSSON E., FOXONET S., RÉGNIER E., MOSNIER C., TONDU F., BROUTIN-RENAUD J., COGNIE B., DE MADDALENA A., KABASAKAL H., ZIANI N., 2024. Additional historical records of great white sharks *Carcharodon carcharias* caught in the Gulf of Lion, Northwestern Mediterranean Sea, between the 1920s and 1950s. *Ann., Ser. Hist. Nat.*; Koper, 34 (2): 239-250.
- EBERT D.A., DANDO M., 2020. *Field Guide to Sharks, Rays & Chimaeras of Europe and the Mediterranean*. Princeton University Press, Princeton, USA: 1-383.
- EUROPEAN UNION, 2017. Council regulation (EU) 2017/127 of 20 January 2017 fixing for 2017 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for fishing vessels, in certain non-Union waters. *Off. J. Eur. Union*, L24 (1): 1-172.
- FARRUGIO H., 2013. *Fisheries in the Gulf of Lions*. RAC/SPA publ., Tunis, Tunisia: 1-79.
- FERGUSON I.K., 1996. Distribution and autecology of the white shark in the eastern North Atlantic Ocean and the Mediterranean Sea. In: *Great white sharks*, Klimley A.P., Ainley D.G. (Eds.), Academic Press: 321-345.
- FERRETTI F., MYERS R.A., SERENA F., LOTZE H.K., 2008. Loss of large predatory sharks from the Mediterranean Sea. *Conserv. Biol.*, 22 (4): 952-964.
- FERRETTI F., SHEA B.D., GAMBARDILLA C., JENRETTE J.F., MORO S., ECHWIKI K., SCHALLERT R.J., GALLAGHER A.J., BLOCK B.A., CHAPPLE T.K., 2024. On the tracks of white sharks in the Mediterranean Sea. *Front. Mar. Sci.*, 11 (1425511).
- JACOB E., CABRAL M., SCHOHN T., BELLONI B., BOUDOURESQUE C.F., THIBAUT T., RUITTON S., ASTRUCH P., 2024. Understanding the ecosystem quality of Mediterranean shallow rocky reefs: Insights from the application of ecosystem-based indices. *Mar. Pollut. Bull.*, 209 (117050): 1-11.
- JAMBURA P., TÜRTSCHER J., DE MADDALENA A., GIOVOS I., KRIWET J., RIZGALIA J., AL MABRUK S.A.A., 2021. Using citizen science to detect rare and endangered species: New records of the great white shark *Carcharodon carcharias* off the Libyan coast. *Ann. Ser. Hist. Nat.*; Kopper, 31 (1): 51-57.

- KABASAKAL H., BAYRI E., 2021. Great white sharks, *Carcharodon carcharias*, hidden in the past: Three unpublished records of the species from Turkish waters. *Ann. Ser. Hist. Nat.*; Koper, 31 (2): 195-202.
- KABASAKAL H., BAYRI E., ALKAN G., 2022. Distribution and status of the great white shark, *Carcharodon carcharias* (Linnaeus, 1758), in Turkish waters: a review and new records. *Ann. Ser. Hist. Nat.*; Koper, 32: 325-342.
- MONACO A., LUDWIG W., PROVANSAL M., PICON B. (coord.), 2009. *Le golfe du Lion—Un observatoire de l'environnement en Méditerranée*. Éditions Quæ, Versailles: 1-338.
- MORO S., JONA-LASINIO G., BLOCK B., MICHELI F., DE LEO G., SERENA F., BOTTARO M., SCACCO U., FERRETI F., 2020. Abundance and distribution of the white shark in the Mediterranean Sea. *Fish Fisheries*, 21 (2): 338-349.
- NATANSON L.J., SKOMAL G.B., 2015. Age and growth of the white shark, *Carcharodon carcharias*, in the western North Atlantic Ocean. *Mar. Freshw. Res.*, 66 (5): 387-398.
- ODY D., BOMPAR J.M., RATEL M., 2016. *Les cétacés: peuplement de Méditerranée, écologie et statut de conservation*. Souffleurs d'écume publ., La Celle, France: 1-87.
- OLAYA-PENZONE L., ESPADA R., MARTÍN MORENO E., CÁRDENAS MARCIAL I., GARCÍA-GÓMEZ J.C., 2020. Injuries, healing and management of common dolphins (*Delphinus delphis*) in human-impacted waters in the south Iberian Peninsula. *J. Mar. Biol. Ass. UK*, 100 (2): 315-325.
- PERSONNIC S., BOUDOURESQUE C.F., ASTRUCH P., BALLESTEROS E., BLOUET S., BELLAN-SANTINI D., BONHOMME P., THIBAUT-BOTHA D., FEUNTEUN E., HARMELIN-VIVIEN M., PERGENT G., PERGENT-MARTINI C., PASTOR J., POGGIALE J.C., RENAUD F., THIBAUT T., RUITTON S., 2014. An ecosystem-based approach to assess the status of a Mediterranean ecosystem, the *Posidonia oceanica* seagrass meadow. *PLoS One*, 9 (6): 1-17 (e98994).
- SCHROEDER K., TANHUA T., CHIGGIATO J., VELAORAS D., JOSEY S.A., LAFUENTE J.G., VARGAS-YÁÑEZ M., 2023. The forcings of the Mediterranean Sea and the physical properties of its water masses. In: *Oceanography of the Mediterranean Sea*. Elsevier publ.: 93-123.
- SKOMAL G.B., BRAUN C.D., CHISHOLM J.H., THORROLD S.R., 2017. Movements of the white shark *Carcharodon carcharias* in the North Atlantic Ocean. *Mar. Ecol. Prog. Ser.*, 580: 1-16.
- SOLDO A., BAKIU R., 2024. Additional historical records of the great white shark, *Carcharodon carcharias* (Lamniformes: Lamnidae), in the eastern Adriatic: Updating regional occurrence of an endangered shark. *Ann. Ser. Hist. Nat.*; Koper, 34 (1): 11-20.
- SOLDO A., BRADAI M.N., WALLS, R.H.L., 2016. *Carcharodon carcharias* (Mediterranean assessment). *The IUCN Red List of threatened species* 2016: e.T3855A16527829. Accessed on 23 December 2024.
- STAMBLER N., 2014. The Mediterranean Sea – Primary productivity. In: *The Mediterranean Sea: Its history and present challenges*, Goffredo S., Dubinsky Z. (Eds.), Springer Science and Business Media, Dordrecht, Netherlands: 113-121.
- TAUPIER-LETAGE I., PIAZZOLA J., ZAKARDJIAN B., 2013. Les îles d'Hyères dans le système de circulation marine et atmosphérique de la Méditerranée. *Sci. Rep. Port-Cros Natl. Park*, 27: 29-52.
- TESTOR P., BOSSE A., HOUPERT L., MARGIRIER F., MORTIER L., LEGO H., DAUSSE D., LABASTE M., KARSTENSEN J., HAYES D., OLITA A., HESLOP E., D'ORTENZIO F., MAYOT N., LAVIGNE H., DE FOMMERVAULT O., COPPOLA L., PRIEUR L., TAILLANDIER V., DURRIEU DE MADRON X., BOURRIN F., MANY G., DAMIEN P., ESTOURNEL C., MARSALÉIX P., TAUPIER-LETAGE I., RAIMBAULT P., WALDMAN R., BOUIN M.N., GIORDANI H., CANIAUX G., SOMOT S., DUCROCQ V., CONAN P., 2018. Multiscale observation of deep convection in the northwestern Mediterranean Sea during winter 2012-2013 using multiple platforms. *J. Geophys. Res. Oceans*, 123: 1745-1776.