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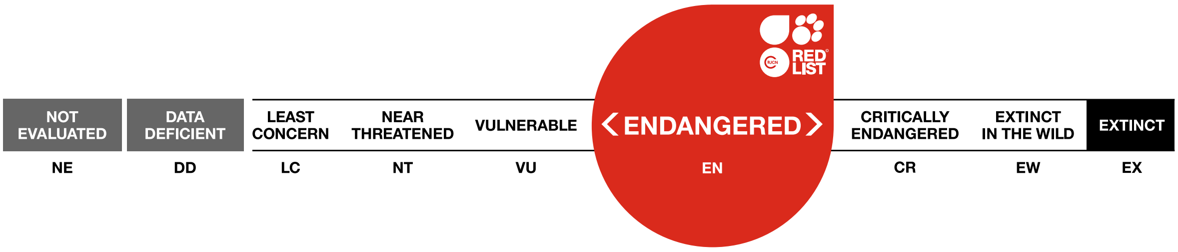
Scope(s): Global, Mediterranean
Language: English

Physeter macrocephalus Mediterranean subpopulation, Sperm Whale

Assessment by: Pirotta, E., Carpinelli, E., Frantzis, A., Gauffier, P., Lanfredi, C., Pace, D.S. & Rendell, L.E.



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Taxonomy

Kingdom	Phylum	Class	Order	Family
Animalia	Chordata	Mammalia	Cetartiodactyla	Physeteridae

Scientific Name: *Physeter macrocephalus Mediterranean subpopulation* Linnaeus, 1758

Synonym(s):

- *Physeter catodon* Linnaeus, 1758

Parent Species: See *Physeter macrocephalus*

Common Name(s):

- English: Sperm Whale
- French: Cachalot
- Spanish; Castilian: Cachalote
- German: Pottwal
- Italian: Capodoglio

Taxonomic Source(s):

Society for Marine Mammalogy (SMM). 2020. List of Marine Mammal Species and Subspecies. May 2020. Yarmouth Port, MA: Committee on Taxonomy, Society for Marine Mammalogy. Available at: https://marinemammalscience.org/species-information/list-marine-mammal-species-subspecies/. (Accessed: 26 June 2020).

Assessment Information

Red List Category & Criteria: Endangered C2a(ii) ver 3.1

Year Published: 2021

Date Assessed: November 16, 2020

Justification:

Mediterranean Sperm Whales qualify as a subpopulation based on genetic data. Uncertainties result in several plausible listing criteria and categories. The subpopulation could qualify as EN under criterion D using the lowest plausible number of mature individuals (250). However, using this criterion the more likely category would be VU, with < 1,000 mature individuals. The subpopulation qualifies as EN using the C2a(ii) criterion, based on the following considerations:

• The total size of the subpopulation is inferred to lie in the range 500-5,000. Given available estimates of the proportion of mature individuals and outstanding uncertainties, the number of mature Sperm Whales in the Mediterranean is thus likely below 2,500.

• A continuing decline is inferred. In recent years, bycatch in illegal fisheries has decreased but continued, and the incidence of ship strikes has likely risen. Effective management measures for these threats are lacking, and, given the species' low growth rates, low levels of mortality are potentially unsustainable. Therefore, a continuing decline is both plausible and precautionary.

• Genetic analyses have not provided evidence for within-region population structure. Sperm Whales are thought to roam widely across the Mediterranean, and it is therefore parsimonious to assume that they form a single subpopulation.
The EN listing using C2a(ii) relies on the most comprehensive data for this subpopulation and is chosen as best representing the level of threat.

Previously Published Red List Assessments

2012 – Endangered (EN)
https://dx.doi.org/10.2305/IUCN.UK.2012-1.RLTS.T16370739A16370477.en

Geographic Range

Range Description:

In the Mediterranean Sea, Sperm Whales are widely distributed from the Gibraltar Strait area in the west to the Levant Basin in the east. In the western basin, the species is predictably present in the Gibraltar Strait, around the Balearic Islands, in the Liguro-Provençal Basin and in the Tyrrhenian Sea. In the eastern basin, Sperm Whales are predictably present along the Hellenic Trench (from the Ionian Sea to the South Cretan Sea), south of Rhodes Island and along the Turkish coast as far as the western part of Antalya Bay. They are also present off west and south Cyprus, and in the Aegean Sea, north of the Cyclades Islands and in the Ikaria basin. The species is rare in the Strait of Sicily and vagrant in the northern and central Adriatic Sea. It is absent from the Black Sea and the Turkish Straits System.

The distribution map for this species was based on the known and inferred distribution of the species, with the polygon then clipped to the 200 m contour to remove depths <200 m.

Country Occurrence:

Native, Extant (resident): Albania; Algeria; Croatia; Cyprus; France (Corsica, France (mainland)); Gibraltar; Greece (East Aegean Is., Greece (mainland), Kriti); Italy (Italy (mainland), Sardegna, Sicilia); Monaco; Morocco; Spain (Baleares, Spain (mainland), Spanish North African Territories); Tunisia; Turkey (Turkey-in-Asia, Turkey-in-Europe)

Native, Extant (seasonality uncertain): Egypt (Egypt (African part), Sinai); Israel; Lebanon; Libya; Malta; Montenegro; Syrian Arab Republic

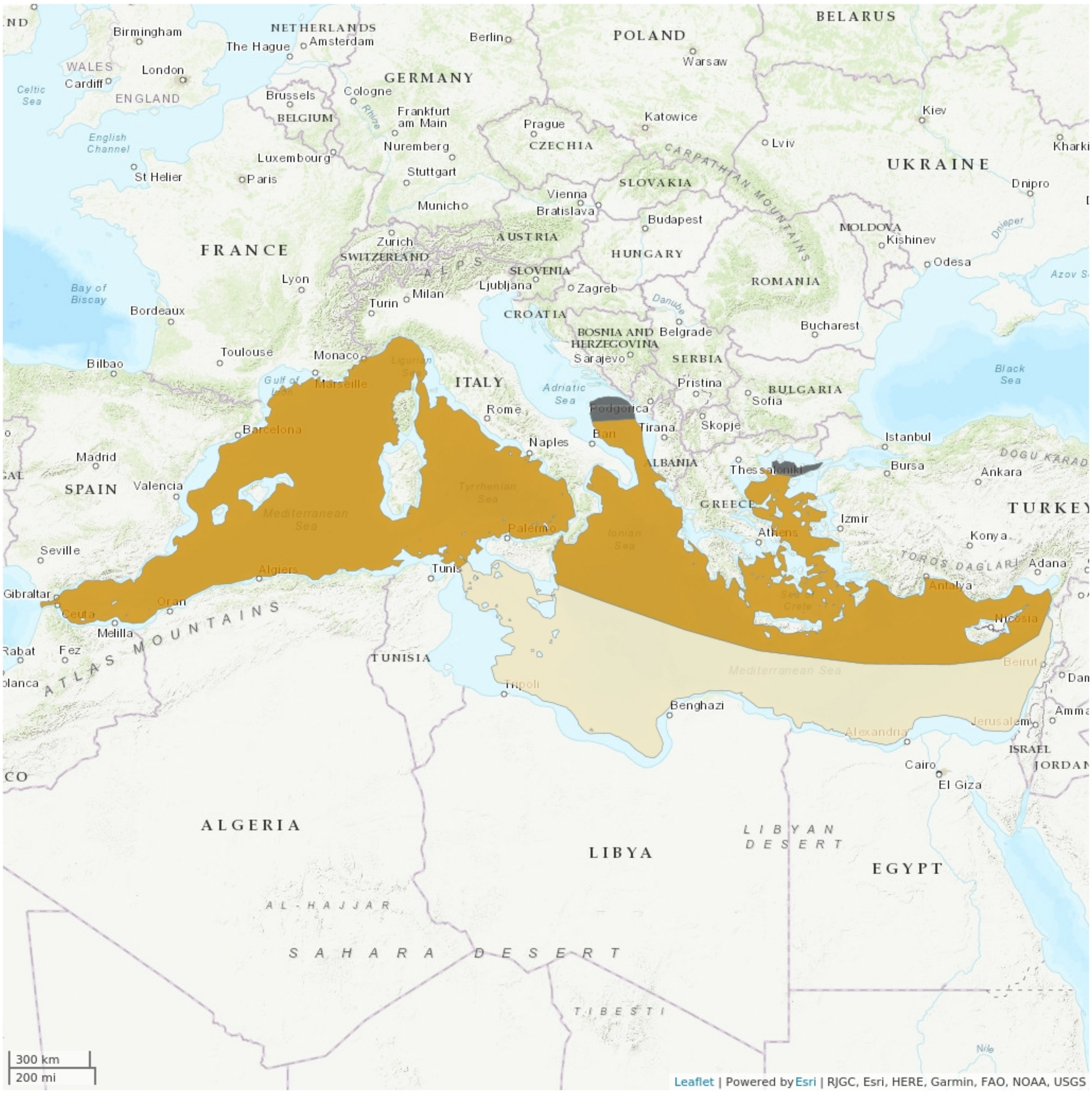
Native, Possibly Extant (seasonality uncertain): Palestine, State of

Native, Presence Uncertain: Bosnia and Herzegovina; Slovenia

FAO Marine Fishing Areas:

Native: Mediterranean and Black Sea

Distribution Map



Legend

EXTANT (RESIDENT)

EXTANT (SEASONALITY UNCERTAIN)

PRESENCE UNCERTAIN

Compiled by:

IUCN Mediterranean Red List 2020

The boundaries and names shown and the designations used on this map do not imply any official endorsement, acceptance or opinion by IUCN.

Population

Population structure and size

Genetic data suggest that Sperm Whales in the Mediterranean constitute a separate subpopulation from that in the connected North Atlantic. Comparison of eastern North Atlantic specimens with individuals sampled in the Mediterranean Sea found significant differences in mitochondrial DNA (mtDNA) haplotype diversity and frequency (Drouot *et al.* 2004a, Engelhaupt *et al.* 2009, Alexander *et al.* 2016). In these studies, all Mediterranean samples shared the same mtDNA haplotype, suggesting that a single matriline has colonised the basin. This haplotype is not unique to the Mediterranean population, but is one of the three most common sequences in Sperm Whales globally (e.g., Rendell *et al.* 2012). Engelhaupt *et al.* (2009) also genotyped 16 microsatellite DNA loci and showed unambiguously that the Mediterranean population was significantly differentiated from the North Atlantic as a whole in nuclear DNA. The Mediterranean sample also exhibited lower microsatellite diversity compared to the North Atlantic. Overall, the differentiation between the Mediterranean and the North Atlantic was much stronger for mtDNA, suggesting that the Mediterranean is home to a philopatric population of matrifocal social groups, from which males may occasionally disperse (Engelhaupt *et al.* 2009). A recent population genomic analysis, which genotyped over 10,000 single-nucleotide polymorphisms (SNPs) in samples from seven Mediterranean and four eastern North Atlantic areas, confirmed the differentiation of Mediterranean Sperm Whales from the North Atlantic population (Violi *et al*. 2019). Low levels of unidirectional, recent gene flow from the Atlantic (less than one individual per generation) was suggested by the presence of a small number of admixed individuals in some areas of the western Mediterranean basin (Violi *et al*. 2019), supporting the occurrence of occasional movements of males, as proposed by Engelhaupt *et al.* (2009). Thus, the Mediterranean Sperm Whales meet the suggested subpopulation guidelines of one successful migrant or less per year (Gärdenfors *et al.* 2001).

Other, non-genetic observations also suggest geographic isolation, deriving from photographic identification, analyses of vocalisations, and anatomical measurements of stranded animals. A basin-wide study comparing eight photo-identification catalogues found movements of whales within the western Mediterranean, but no match with the eastern North Atlantic (Carpinelli *et al.* 2014). Additionally, all age classes of Sperm Whales are found within the Mediterranean, and the occurrence of neonates (Gannier *et al.* 2002, Frantzis *et al.* 2003, 2014, Moulins and Würtz 2005, Drouot-Dulau and Gannier 2007, Pirotta *et al.* 2011, Calogero *et al.* 2019) confirms that calving takes place there. In the eastern Mediterranean, social groups, loose male aggregations and solitary adult males are present year-round (Frantzis *et al.* 2003, 2014). In the western basin, solitary males and male aggregations are present in all areas of occurrence. However, social groups with calves have a more restricted distribution, being common around the Balearic Islands (Pirotta *et al*. 2011) and in the Tyrrhenian Sea (Pace *et al*. 2014). The distribution, and therefore structure, of the population is likely dynamic. Social groups have been increasingly encountered in the Ligurian Sea (Moulins and Würtz 2005, Di Méglio and David 2008, Pierantonio *et al.* 2008, Tardy *et al.* 2016, Calogero *et al.* 2019), but have not been sighted in the Strait of Gibraltar and Alborán Sea until 2017 (CIRCE/Turmares/Alnilam, unpublished data), while they used to be common in the Strait of Messina historically (Bolognari 1951). Vocally, Mediterranean Sperm Whales have a distinctive repertoire of codas, the stereotyped patterns of clicks that Sperm Whales use for communication. Repertoire differences among populations have been interpreted as indicative of cultural differences (Whitehead 2003). Although more than 25 coda types have been recorded in the Mediterranean (Drouot and Gannier 1999), the coda repertoire is dominated by one pattern (the “3+1” coda), both for solitary males and, to a lesser extent, within social units (Pavan *et al.* 2000, Drouot *et al.* 2004b, Frantzis and Alexiadou 2008, Pace 2016). This coda pattern is not common in adjacent waters of the Atlantic (Borsani *et al.* 1997). More than 50% of codas produced by Mediterranean solitary males are “3+1” codas (Frantzis and Alexiadou 2008). This repertoire variation also supports the isolation of the population. Finally, anatomically, Mediterranean males seem not to grow longer than 14-15 m, as measured in stranded animals (Frantzis *et al.* 2003, Bearzi *et al.* 2011) and acoustically (Drouot *et al.* 2004a, Frantzis and Alexiadou 2008, Frantzis *et al.* 2014, Caruso *et al.* 2015, Pace 2016, Pierantonio *et al.* 2016), although they potentially did in the past according to a museum specimen (Minelli 2014). This is in contrast with other regions, where males regularly grow longer than 17 m (Whitehead 2003). The overall picture is consistent between genetic and other information, which all support the isolated nature of the population.

There is no genetic evidence of population fragmentation between the western and eastern basins, in concordance with reports of inter-basin movements (Frantzis *et al.* 2011). Therefore, the assumption that Sperm Whales form a single subpopulation within the Mediterranean is currently the most parsimonious. However, recent, preliminary results suggest there could be some heterogeneity within the western basin (Violi *et al.* 2019). Future research should further investigate the occurrence of any population structuring within the Mediterranean.

Precisely determining population size is a challenge. There is a range of information from local estimates derived from photo-identification data. In the northwestern part of the Pelagos Sanctuary, 356 sightings were recorded between 1990 and 2014 over an area of approximately 30,000 km^2, corresponding to a total of 136 photo-identified individuals, and a modelled population size of 43-56 individuals (coefficient of variation (CV) = 0.40) (Lanfredi *et al.* 2018). About 400 individuals have been estimated to use the area between the Ligurian Sea and the Balearic Islands (Rendell *et al.* 2014). In the Strait of Gibraltar, 47 individuals were identified from 1999 to 2011 (Carpinelli *et al.* 2014), and an additional 29 from 2012 to 2019 (Gaméz 2019, Gámez pers. comm.). In the Tyrrhenian Sea, 60 individuals were identified from 2003 to 2012 (Pace *et al.* 2014), with 20 additional whales encountered between 2013 and 2015 (Pace 2016).

There have also been a number of larger-scale survey efforts. For example, aerial surveys covering about 22% of potential Sperm Whale habitat in the western basin, including the Gulf of Lion and the Pelagos Sanctuary, estimated a summer abundance of 369 individuals (95% confidence interval (CI) = 84-1,691) and a winter abundance of 565 individuals (95% CI: 123-2,653) (Laran *et al.* 2017), but based on only a few sightings. Boat-based visual and acoustic surveys were carried out in 2003, 2004, 2007 and 2013, covering over 35% of potential Sperm Whale habitat in the western basin and over 75% in the eastern basin (Lewis *et al.* 2007, Boisseau *et al.* 2010, Lewis *et al.* 2018). Combining all estimates and extrapolating densities to unsurveyed areas, Lewis *et al*. (2018) estimated the total abundance for the Mediterranean at 1,842 animals (no variance estimated), with the density of Sperm Whales in the surveyed southwestern Mediterranean over 17 times higher than for the surveyed eastern Mediterranean (2.12 and 0.12 whales per 1,000 km^2 respectively). Estimated abundance for the surveyed area of the eastern basin was 147 individuals (95% CI: 74-289; CV= 0.36) and the extrapolated overall abundance was 164 individuals (Lewis *et al.* 2018). These results are consistent with the number of Sperm Whales photo-identified along the Hellenic Trench, where a total of 181 individuals (25 solitary males and 136 members of 16 social units) have been photo-identified during 12 years of intense research effort (1998–2009) (Frantzis *et al*. 2014). In this area, the first estimate obtained from capturerecapture methods indicated about 200 Sperm Whales, including both regularly observed individuals and occasional visitors (A. Frantzis, unpublished data). Between 1994 and 2012, 43 opportunistic sightings of Sperm Whales were recorded in Turkish waters, with the highest proportion occurring in the Fethiye Canyon and the north Aegean Sea (Öztürk *et al.* 2013). Dedicated survey effort in this area since 2018 resulted in 23 additional encounters across multiple seasons, during which five different individuals were photo-identified. The sightings mainly consisted of solitary individuals, but social units were also recorded (Akkaya *et al.* 2020). Occurrence of Sperm Whales further east is considered occasional (Kerem *et al.* 2012), although no survey information exists on the Egyptian Exclusive Economic Zone (EEZ), a sizable portion of the eastern basin that contains suitable Sperm Whale habitat. Collectively, this evidence suggests a total of 200–300 individuals for the eastern Mediterranean basin (Frantzis *et al.* 2019).

The largest-scale survey to date is the ACCOBAMS Survey Initiative (ASI), a basin-wide survey undertaken in summer 2018. Preliminary results estimate a total abundance of 4,599 individuals (CV = 0.17; 95% CI: 3,127-6,763) for the whole Mediterranean based on acoustic line-transect techniques (ACCOBAMS 2021). However, these results are inconsistent with local abundance estimates in regularly studied areas, especially in the Tyrrhenian Sea, and feature wide confidence intervals in other areas (especially the Gulf of Lion and Balearic Islands); therefore, they should be taken with caution. A simultaneous aerial survey estimated a total abundance of 1,478 individuals, uncorrected for availability bias (CV = 0.52; 95% CI: 568-3,849; ACCOBAMS 2021), but this estimate was based on only ten sightings (in general, aerial surveys are deemed inappropriate for estimating the abundance of deep-diving species like the Sperm Whale because of low sighting availability). Finally, a recent, preliminary analysis using genetic data suggested an effective population size (Ne) of 2,000 individuals (95% CI: 400-4,000; Violi *et al.* 2019). Overall, there is still a lot of uncertainty surrounding the total Mediterranean population size, with different methodologies often producing variant results, but it seems most likely from available evidence to lie in the range 500-5,000.

Red List criteria use information on the number of mature individuals rather than population size. This remains challenging to assess directly but, if data from the Hellenic Trench can be extrapolated to the entire region, only 45% of the total present-day Mediterranean subpopulation is mature. Taylor *et al.* (2007) estimated this proportion at 56% for Sperm Whales worldwide. Those two values would require the total number of Sperm Whales to be at least either 4,464 (if 56% are mature) or 5,556 (if 45%) if there were to be 2,500 or more mature individuals. Given the present knowledge and outstanding uncertainties, the abundance of mature Sperm Whales in the Mediterranean is on balance likely below 2,500 mature individuals.

Population trend

There is evidence that Sperm Whales were formerly common in portions of the Mediterranean, such as in the Strait of Messina and the waters adjacent to the Aeolian Islands (e.g., Bolognari 1949, 1950, 1951, 1957), at least until the 1960s. Bolognari (1949, 1950, 1951, 1957) reported the frequent occurrence of large "aggregations" or "clusters" (*sensu* Whitehead 2003), consisting of as many as 30 individuals, in the area of the Strait of Messina during winter in the late 1940s and early 1950s. Such large groups have not been recorded in more recent times in that area or anywhere else in the Mediterranean. When data on Sperm Whale encounter rates in the western basin started to become available in the mid-1990s (Notarbartolo di Sciara *et al.* 1993, Marini *et al.* 1996), they were inconsistent with the impression given by historical records (Bolognari 1949, 1950, 1951, 1957). For example, in the waters adjacent to the northern and eastern coasts of Sicily, an intensive year-long programme of dedicated surveys in the Strait of Messina and surrounding waters, based on a combination of visual and acoustic techniques (G. Notarbartolo di Sciara, unpublished data), produced 11 Sperm Whale sightings (totalling 15 individuals), all of them in winter, during 125 survey days spanning 12 months. Elsewhere in the western basin, Sperm Whale stranding records in Italy have been relatively stable since the 1980s (around 50 animals per decade; Italian Cetacean Stranding Database 2020), even though the use of driftnets has been phased out since 1996 (Scovazzi 1998). This might suggest that other threats have become more prevalent in recent years. Sperm Whale strandings on the French Mediterranean coast have increased from 5-9 in 1973-2004, to 19 in 2005-2017, partly due to an observed increasing occurrence of ship strikes (Peltier *et al.* 2019) (see also the “Threats” section). Annual stranding records from the Balearic Islands over the period 1998-2019 range from zero to six but do not show any clear trend (data provided by Servei de Protecció d'Espècies, Conselleria de Medi Ambient i Territori, Govern de les Illes Balears).

In the western basin, encounter rates have increased locally in the last decade, e.g., around the Balearic Islands (Pirotta *et al.* 2020a), in the Tyrrhenian Sea off Ischia Island (Mussi *et al.* 2014), and in the Ligurian Sea (Azzellino *et al.* 2017). In the latter area, in particular, Sperm Whales were relatively rare in the late 1980s and early 1990s (Notarbartolo di Sciara *et al.* 1993), but are now frequently encountered (Azzellino *et al.* 2017, Lanfredi *et al.* 2018). However, no trend in local abundance has been evidenced, and increasing local encounter rates are more likely reflective of dynamic spatial distribution, given the slow population growth rate of Sperm Whales (Whitehead 2003). In the eastern basin, information on encounter rates is sparser, but those reported have remained stable in the Hellenic Trench from 1998 until 2014, with a potential decline observed over the period 2017-2020 (A. Frantzis, unpublished data).

Overall, due to the large proportion of the population’s habitat that is not regularly surveyed (particularly in the southern and eastern portions of the basin), and the uncertainty inherent in current population estimates, no conclusive assessment can be made on the overall trend in population size. Previous work has inferred a population decline from the comparison of current encounter rates with historical records, the ongoing threats faced by the population (see ‘Threats’ section below), and the absence of effective management measures to mitigate them (Notarbartolo di Sciara 2014, Rendell and Frantzis 2016).

If fisheries bycatch was the primary threat driving historical declines, and that threat has been reduced in recent years, it is possible that the decline has ceased. However, given ongoing illegal fisheries bycatch and increased ship strikes (see the ‘Threats’ section), it is also plausible that the decline is continuing. Moreover, Sperm Whales are long-lived mammals (oldest age of 59 y, age of first reproduction of 12 y and interbirth interval of 5 y, as summarised in Taylor *et al.* 2007). Growth rates are therefore only a few percent per year, which makes even low levels of human-caused mortality potentially unsustainable. The Red List Guidelines recommend that, when dealing with uncertainty, assessors adopt a precautionary but realistic attitude. Therefore, a continuing decline is inferred because such a decline is both plausible and precautionary given the absence of effective management measures for the most serious threats.

Current Population Trend: Decreasing

Habitat and Ecology **(see Appendix for additional information)**

Preferred Sperm Whale habitat in the Mediterranean consists mostly of deep continental slope waters where topographic features (e.g., a steep seafloor, underwater canyons and seamounts) interact with ocean circulation to promote the availability and abundance of mesopelagic cephalopods, the species' preferred prey (Azzellino *et al.* 2008, de Stephanis *et al*. 2008, Praca and Gannier 2008, Praca *et al*. 2009, Pirotta *et al.* 2011, Fiori *et al.* 2014, Mussi *et al.* 2014, Tepsich *et al.* 2014, Pace 2016, Azzellino *et al.* 2017, Pace *et al*. 2018, 2019, Virgili *et al.* 2019, Claro *et al*. 2020, Pirotta *et al*. 2020a). Sperm Whales also frequently occur in the deep offshore waters of the abyssal plains, away from topographic features, as indicated by a series of acoustic surveys across the basin (Lewis *et al.* 2018, ACCOBAMS 2021), possibly in association with frontal systems and other mesoscale oceanographic features (Gannier and Praca 2007, Praca and Gannier 2008, Virgili *et al.* 2019).

Adult males of oceanic Sperm Whale populations are known to segregate from social units of females and immatures as they reach sexual maturity. Males live separately from the social units in higher latitudes, some reaching as far as the ice edge. Some of the larger adult males migrate latitudinally to join social units, which remain at lower latitudes year-round. These males rove between social groups, associating with a given social group for only a few hours at a time for breeding (Whitehead 2003). A generally similar social system appears to occur in parts of the western and central Mediterranean, with males using more northern waters in the Gulf of Lion and Ligurian Sea in the summer months, mainly for foraging (Watwood *et al*. 2006, Giorli *et al.* 2016, Lanfredi *et al.* 2016), while social units tend to remain south of 41°N (Drouot *et al.* 2004b). However, social units may also be found occasionally in the north (Moulins and Würtz 2005, Di Meglio and David 2008, Pierantonio et al. 2008), and males are also regularly observed feeding in the waters around the Balearic Islands, co-occurring with social units (Pirotta *et al.* 2011, Rendell *et al.* 2014, Pirotta *et al.* 2020a), and in the Tyrrhenian Sea off Ischia Island (Mussi *et al.* 2014, Pace 2016, Pace *et al*. 2014, 2018). Around the Balearic Islands, males and social units appear to segregate at fine spatial scales of approximately 10 km (Pirotta *et al.* 2011, Jones *et al.* 2016, Pirotta *et al.* 2020a, Pirotta *et al.* 2020b). In some parts of the eastern basin, social groups of females with immatures and mature males are both found in the same area year-round (Frantzis *et al.* 1999, 2003, 2014; Akkaya *et al.* 2020), although in the northern part of the Hellenic Trench only social groups are present and large males are rarely seen. When large males are present in this study area, it is almost always in a reproductive context (i.e., associated with a social group). These differences suggest that social structure in the Mediterranean might vary from those in other oceans. Social groups typically consist of 10–12 individuals, including at least 1–2 calves (Gannier *et al.* 2002).

This population is mobile over large scales, but movements appear largely irregular rather than migratory. Based on a combination of photo-identification and acoustic data, Drouot-Dulau and Gannier (2007) observed some latitudinal movements of sexually mature males between the northwestern Mediterranean and the waters off the Balearic Islands, ranging in excess of 500 km and lasting seven days or less. Further regular movements of individuals were confirmed by photo-identification between the Balearic Islands, Gulf of Lion, and the Ligurian Sea (Rendell *et al*. 2014) and between the Ligurian Sea and the Tyrrhenian Sea (Carpinelli *et al.* 2014). Laran and Drouot-Dulau (2007) observed the highest abundance of Sperm Whales in the Ligurian Sea between August and October, which is indicative of the species' movement within a wider area. Long-distance movements within the western basin, connecting the Strait of Gibraltar with the Balearic Islands, the Gulf of Lion and the Ligurian Sea, also emerged from the comparison of several photo-identification catalogues in the region, but no movement was detected between the western and eastern basin (Carpinelli *et al.* 2014). In the eastern Mediterranean, both solitary males and social groups may remain in a limited area for more than a month, or may visit that area repeatedly during the same summer season, indicating that they stay in neighbouring waters (A.

Frantzis, unpublished data). Some solitary males and several social units have been re-sighted in the same area for up to three and six different years, respectively, during ongoing long-term studies (Frantzis *et al.* 2003, Frantzis *et al.* 2014). The occurrence of long-range, inter-basin movements was first demonstrated from the comparison of fluke photos of seven individuals that stranded in the Adriatic Sea in 2009 with photos from the western and eastern basins (Frantzis *et al.* 2011, Mazzariol *et al.* 2011), but the frequency of exchanges between basins is unknown.

Information on the foraging ecology of Sperm Whales in the Mediterranean remains sparse, but it appears quite similar to their oceanic counterparts, focusing on mesopelagic squids. Both solitary males and social groups of Sperm Whales are thought to feed throughout their range. Analysis of stomach contents of individuals stranded in the eastern basin suggested a diet dominated by cephalopods of the genera *Histioteuthis* and *Octopoteuthis* (Roberts 2003, Foskolos *et al.* 2020). Stable isotope analyses highlighted some dietary differences between the sexes, reinforcing the idea that they might be segregating at fine scales (Pirotta *et al.* 2020b). Some studies have suggested that Sperm Whales segregate spatially from potential competitors, such as beaked whales (Azzellino *et al*. 2012, Tepsich *et al.* 2014). In contrast, Giorli *et al.* (2016) found the species to overlap with other teuthivores in one canyon area of the Ligurian Sea.

Systems: Marine

Use and Trade **(see Appendix for additional information)**

The species is not utilized.

Threats **(see Appendix for additional information)**

Mediterranean Sperm Whales face a broad spectrum of anthropogenic threats, at higher intensity than oceanic counterparts because of the confined and heavily used nature of Mediterranean waters. Activities that result in direct mortality, such as bycatch in illegal driftnets and collisions with ships, together with the noxious effects of noise, pollution, ingestion of debris, disturbance from whale watching operations, and possibly prey depletion and climate change, could all be threatening the survival of the Mediterranean population and contributing to an inferred continuing decline (Notarbartolo di Sciara 2014, Rendell and Frantzis 2016).

Until recently, entanglement in pelagic swordfish and tuna driftnets had been the principal, and very serious, threat to this population, causing considerable and likely unsustainable mortality since the mid-1980s, when this type of fishery started to be used on a large scale (Notarbartolo di Sciara 1990, 2014). The recorded number of Sperm Whales found dead or entangled between 1971 and 2004 in Spain, France and Italy (combined) was 229, only 22 of which (10%) occurred between 1971 and 1986, when the Italian stranding program started, and there is no reason to believe that discovery or documentation were anywhere near complete. Most of the strandings in Italy and Mediterranean Spain during this period were caused by entanglement in driftnets, as evident from the reported presence of net fragments or characteristic marks on the whales' bodies (Podestà and Magnaghi 1989, Làzaro and Martin 1999). Cagnolaro and Notarbartolo di Sciara (1992) reported that for 83% of 347 cetaceans stranded in Italy from 1986 to 1990 (inclusive), which included 56 Sperm Whales, the likely cause of death was related to net entanglement. Around the Balearic Islands, over the period 1998-2019, interaction with fishing gear was reported as the cause of the stranding in 1 out of 3 records in 2004, and 4 out of 6 records in 2006 (with no other causes established in the remaining cases; data provided by Servei de Protecció d'Espècies, Conselleria de Medi Ambient i Territori, Govern de les Illes Balears). The use of pelagic driftnets has been banned in the Mediterranean since 2002. As a result, entanglements of Sperm Whales have decreased in recent years, but fleets from many countries (e.g., Algeria, Italy, Morocco, Turkey) continue to fish illegally using these nets (Notarbartolo di Sciara 2014). Thus, this source of Sperm Whale mortality is ongoing (e.g., Tudela *et al.* 2003, Pace *et al*. 2008, Cornax and Pardo 2009), as confirmed by the unusual mortality event that occurred in the central Mediterranean in 2018-2019, when 6 individuals were found entangled in fishing gear (Mazzariol *et al.* 2020).

Intense maritime traffic crossing Sperm Whale habitat can lead to collisions between the whales and large vessels such as cargo ships, tankers, hydrofoils and high-speed ferries (de Stephanis and Urquiola 2006, Italian Cetacean Stranding Database 2020). More than 6% of 111 Sperm Whales stranded in Italy (1986-1999) and Greece (1982-2001) died after a collision with a ship, and 6% of 61 photo-identified individuals (39 in Greece and 22 in Italy) bore wounds or scars caused by a vessel strike (Pesante *et al.* 2002, Abdulla and Linden 2008). Sperm Whale strandings on the French Mediterranean coast have increased from 5-9 in 1973-2004, to 19 in 2005-2017, and, in a combined large cetacean sample across the study period, including four Sperm Whales, 13% showed evidence of a ship strike (Peltier *et al.* 2019). Of the 24 strandings of Sperm Whales recorded from 1992 to 2017 along the Greek coasts where a macroscopic carcass examination was possible, 13 and possibly three more cases (i.e., 54-67%) concerned individuals with propeller marks or other scars indicating a ship strike (Frantzis *et al.* 2019). In addition, at least four out of 181 individuals photo-identified during surveys along the Hellenic Trench had deep wounds apparently caused by propellers (Frantzis *et al.* 2019). Evidence of vessel strikes is also increasingly emerging from the photo-identification of individuals around the Balearic Islands (J.M. Brotons pers. comm.), suggesting this threat applies across most areas of reported occurrence.

Aside from interactions leading to direct mortality or injury, maritime traffic, fishing and leisure vessels can disturb exposed individuals, particularly in the case of commercial whale watching operations that deliberately approach Sperm Whales (e.g., Magalhães *et al.* 2002). Moreover, the underwater noise generated by seismic surveys for oil and gas exploration, naval sonar operations, and illegal dynamite fishing, which are increasingly conducted within the habitats occupied by Sperm Whales in the Mediterranean (Notarbartolo di Sciara 2014), can also elicit behavioural or physiological changes (Nowacek *et al*. 2007, Duarte *et al*. 2021). In turn, changes in individual behaviour or physiology can affect individual energy budgets, demographic rates and, ultimately, population dynamics (Pirotta *et al.* 2018). The variety of noise sources with heterogeneous characteristics, the uncertainty on individual exposure rates, and the sublethal nature of most associated effects make it hard to quantify any population-level consequences. However, noise is a pervasive stressor across the basin, overlapping with large portions of Sperm Whale critical habitat, and we thus believe it could cause slow but significant declines in the population.

Marine litter, in large part plastic items, is often found in the digestive tract of stranded Sperm Whales (e.g., de Stephanis *et al.* 2013, Mazzariol *et al.* 2011, Mazzariol *et al.* 2018), sometimes with fatal consequences (Jacobsen *et al.* 2010). For example, plastic debris was found in 33% of Sperm Whales stranded in Italy between 1998 and 2018 (University of Padua 2019). Macroplastics (> 5 mm) were found in the stomachs of six stranded Sperm Whales in Greece, out of 10 examined, with plastic bags representing the most common finding (Alexiadou *et al.* 2019). Fishing gear (i.e., nets and ropes) was found in three Sperm Whales (Alexiadou *et al.* 2019). Although the presence of plastic and other forms of marine litter in the gastrointestinal tract is not necessarily lethal (Mazzariol *et al.* 2011, Mazzariol *et al.* 2020), plastic pollution is an emerging problem for Sperm Whales, with a worryingly growing trend (Poeta *et al.* 2017, University of Padua 2019).

Marine pollution (e.g., via agricultural or industrial discharges) is also a source of concern in the Mediterranean. Sperm Whales are long-lived apex predators, thus prone to accumulate high concentrations of toxic xenobiotic compounds, such as persistent organic pollutants (POPs) and trace element metals, including mercury, through biomagnification and bioaccumulation (Praca *et al.* 2011, Notarbartolo di Sciara 2014, Pinzone *et al.* 2015, Pinzone *et al.* 2019). Sperm Whales appear prone to accumulate arsenic, and the Mediterranean population had one of the highest levels measured globally (Savery *et al.* 2014), although the health implications are not clear. There is also evidence for elevated aluminium levels (Squadrone *et al.* 2015). Such trends are very difficult to mitigate given the broad range of sources.

In addition to these anthropogenic threats, evidence of infection from cetacean morbillivirus, previously thought to affect only striped dolphins in the Mediterranean Sea, has been found in Sperm Whales stranded in Italy in 2014 (Mazzariol *et al.* 2017), even though the potential for related epizootics in the species is unknown. Cetacean morbillivirus has also been found in five Sperm Whales that died during an unusual mortality event involving 16 animals, which took place between November 2018 and July 2019 in the central Mediterranean (Mazzariol *et al.* 2020). Additional animals were reported in Corsica (two in November 2018) and in Algeria (eight in May 2019). Epidemiological and molecular data suggested a relevant role of this virus in causing the anomalous event (Mazzariol *et al.* 2020). It has been suggested that brominated flame retardants (BFRs) are reaching levels in this population that could potentially affect immune function (Zaccaroni *et al.* 2018), so the population may be especially vulnerable to such outbreaks.

Conservation Actions **(see Appendix for additional information)**

Sperm Whales are listed by the Bonn Convention - CMS (Appendices I and II), the Bern Convention (Appendix II), CITES (Appendix I), ACCOBAMS (a priority species for conservation action) and the Protocol on Specially Protected Areas and the Biological Diversity in the Mediterranean of the Barcelona Convention (Annex II). The International Convention for the Regulation of Whaling confers full protection from commercial whaling on Sperm Whale under the moratorium on commercial whaling that took effect from 1986. An international sanctuary for the conservation of Mediterranean cetaceans, called the Pelagos Sanctuary, where driftnet fishing was progressively phased out, was established in 1999, encompassing key Sperm Whale habitat in portions of the Provençal, Corsican, Ligurian, Tyrrhenian and northern Sardinian Seas (Notarbartolo di Sciara *et al*. 2008). The Mediterranean subpopulation was previously assessed as Endangered (Notarbartolo di Sciara *et al.* 2012).

For the specific purpose of reducing the risk of collisions between Sperm Whales and vessels in the Strait of Gibraltar, the "Notice to Mariners to protect cetaceans from the risk of ship collisions in the Strait of Gibraltar", published in January 2007 by the "Instituto Hidrográfico de la Marina" (Ministry of Defence, Spain), established a security area characterized by high densities of Sperm Whales, where crossing ships are urged to limit their speed to 13 knots or slower (following the suggestions by Laist *et al.* 2001) from April to August and to navigate with particular caution. However, there is no evidence of compliance by mariners (Silber *et al*. 2012). Moreover, this measure is seasonal, while Sperm Whales have been observed in the region year-round (Gauffier *et al.* 2012). In 2018, the Spanish Government also declared a large MPA named “Migration corridor for Mediterranean cetaceans” (*Corredor de migración de cetáceos del Mediterráneo*), covering an area of about 46,000 km^2 between the Balearic Islands and the Iberian Peninsula, adopted in 2019 as a Specially Protected Areas of Mediterranean Importance (SPAMI). Within this area, no active marine geological research and exploration projects or oil and gas extraction activities are allowed (except for ongoing permits). In 2019, the Cabrera Archipelago Maritime-Terrestrial National Park (or, in Catalan, Parc Nacional Maritimo-Terrestre de l'Arxipèlag de Cabrera) in the Balearic Islands was extended by 808 km^2 (now covering a total of 908 km^2) to protect important offshore habitat for several marine predators, including the Sperm Whale.

In 2017, 26 areas within the Mediterranean region received the status of Important Marine Mammal Areas (IMMAs), defined as “discrete portions of habitat, important to marine mammal species, that have the potential to be delineated and managed for conservation” (IUCN Marine Mammal Protected Areas Task Force 2017). Among Mediterranean IMMAs, six areas have been designated for their recognised importance to Sperm Whales: the Alborán Corridor and Alborán Deep, the Campanian and Pontino Archipelago, the Hellenic Trench, the Balearic Islands Shelf and Slope, and the North West Mediterranean Sea, Slope and Canyon System. In addition, the designation process identified the Sperm Whale as present in the Northern Sporades, the Shelf of the Gulf of Lion, the Strait of Gibraltar and Gulf of Cadiz, the waters of Ischia and Ventotene, and the Western Ligurian Sea and Genoa Canyon IMMAs. Despite this important step towards the protection of Sperm Whales in the basin, management of human activities in the offshore habitat used by the species remains problematic. For example, in the Hellenic Trench, major shipping routes run on or close to the 1,000 m depth contour, resulting in the observed ship strikes. An IWC-ACCOBAMS workshop recommended that the Greek Ministry of Maritime Affairs and Insular Policy work with other Greek Ministries and relevant stakeholders including the shipping industry, the European Commission and other countries, NGOs, IGOs and scientists to put in place risk reduction measures in the Hellenic Trench (IWC 2019). Other areas are ripe for similar initiatives, for example around the Balearic Islands, where traffic levels are high.

Across the basin, large portions of what is likely critical habitat for Sperm Whales remain unexplored (e.g., the Egyptian EEZ), or still fall outside any type of protective regime (e.g., the waters off Algeria and southwestern Turkey; ACCOBAMS 2021). Those that have been established vary highly in the effectiveness with which protective measures are deployed and enforced, which is challenging for pelagic waters. Nonetheless, the establishment of a network of genuinely protected areas and the serious enforcement of the prohibition of pelagic driftnets across the basin should be important conservation goals for this species. Due to their keystone position in the mesopelagic ecosystem, Sperm Whales should be considered a good and relatively readily accessible indicator for the health of the ecosystem in the Mediterranean. Ongoing population studies should thus be continued as more information is needed to determine population trends.

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External Resources

For Supplementary Material, and for Images and External Links to Additional Information, please see the Red List website.

Appendix

Habitats

(http://www.iucnredlist.org/technical-documents/classification-schemes)

Habitat	Season	Suitability	Major Importance?
10. Marine Oceanic -> 10.1. Marine Oceanic - Epipelagic (0-200m)	Resident	Suitable	Yes
10. Marine Oceanic -> 10.2. Marine Oceanic - Mesopelagic (200-1000m)	Resident	Suitable	Yes
10. Marine Oceanic -> 10.3. Marine Oceanic - Bathypelagic (1000-4000m)	Resident	Suitable	Yes

Threats

(http://www.iucnredlist.org/technical-documents/classification-schemes)

Threat	Timing	Scope	Severity	Impact Score
3. Energy production & mining -> 3.1. Oil & gas drilling	Ongoing	Minority (50%)	Slow, significant declines	Low impact: 5
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation 2. Species Stresses -> 2.2. Species disturbance		
4. Transportation & service corridors -> 4.3. Shipping lanes	Ongoing	Whole (>90%)	Slow, significant declines	Medium impact: 7
	Stresses:	2. Species Stresses -> 2.1. Species mortality 2. Species Stresses -> 2.2. Species disturbance		
5. Biological resource use -> 5.4. Fishing & harvesting aquatic resources -> 5.4.3. Unintentional effects: (subsistence/small scale) [harvest]	Ongoing	Minority (50%)	Negligible declines	Low impact: 4
	Stresses:	2. Species Stresses -> 2.1. Species mortality		
5. Biological resource use -> 5.4. Fishing & harvesting aquatic resources -> 5.4.4. Unintentional effects: (large scale) [harvest]	Ongoing	Whole (>90%)	Rapid declines	High impact: 8
	Stresses:	2. Species Stresses -> 2.1. Species mortality		
6. Human intrusions & disturbance -> 6.1. Recreational activities	Ongoing	Minority (50%)	Negligible declines	Low impact: 4
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation 2. Species Stresses -> 2.2. Species disturbance		
8. Invasive and other problematic species, genes & diseases -> 8.5. Viral/prion-induced diseases -> 8.5.2. Named species	Ongoing	Unknown	Unknown	Unknown
	Stresses:	2. Species Stresses -> 2.1. Species mortality		
9. Pollution -> 9.1. Domestic & urban waste water -> 9.1.3. Type Unknown/Unrecorded	Ongoing	Whole (>90%)	Unknown	Unknown
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation 2. Species Stresses -> 2.1. Species mortality		
9. Pollution -> 9.2. Industrial & military effluents -> 9.2.3. Type Unknown/Unrecorded	Ongoing	Whole (>90%)	Unknown	Unknown

	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation		
9. Pollution -> 9.3. Agricultural & forestry effluents -> 9.3.3. Herbicides and pesticides	Ongoing	Whole (>90%)	Unknown	Unknown
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation 2. Species Stresses -> 2.1. Species mortality		
9. Pollution -> 9.4. Garbage & solid waste	Ongoing	Whole (>90%)	Unknown	Unknown
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation 2. Species Stresses -> 2.1. Species mortality		
9. Pollution -> 9.6. Excess energy -> 9.6.3. Noise pollution	Ongoing	Whole (>90%)	Slow, significant declines	Medium impact: 7
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation 2. Species Stresses -> 2.2. Species disturbance		

Conservation Actions in Place

(http://www.iucnredlist.org/technical-documents/classification-schemes)

Conservation Action in Place
In-place research and monitoring
Action Recovery Plan: Unknown
Systematic monitoring scheme: Yes
In-place land/water protection
Conservation sites identified: Yes, over part of range
Occurs in at least one protected area: Yes
In-place species management
Successfully reintroduced or introduced benignly: No
Subject to ex-situ conservation: No
In-place education
Subject to recent education and awareness programmes: Unknown
Included in international legislation: Yes
Subject to any international management / trade controls: Yes

Conservation Actions Needed

(http://www.iucnredlist.org/technical-documents/classification-schemes)

Conservation Action Needed
1. Land/water protection -> 1.1. Site/area protection
1. Land/water protection -> 1.2. Resource & habitat protection
4. Education & awareness -> 4.3. Awareness & communications

Conservation Action Needed
5. Law & policy -> 5.1. Legislation -> 5.1.1. International level
5. Law & policy -> 5.1. Legislation -> 5.1.2. National level
5. Law & policy -> 5.2. Policies and regulations
5. Law & policy -> 5.4. Compliance and enforcement -> 5.4.1. International level
5. Law & policy -> 5.4. Compliance and enforcement -> 5.4.2. National level

Research Needed

(http://www.iucnredlist.org/technical-documents/classification-schemes)

Research Needed
1. Research -> 1.5. Threats
3. Monitoring -> 3.1. Population trends

Additional Data Fields

Distribution
Lower depth limit (m): 2,000
Upper depth limit (m): 0
Population
Number of mature individuals: 250-2,500
Continuing decline of mature individuals: Yes
Extreme fluctuations: No
Population severely fragmented: No
No. of subpopulations: 1
Continuing decline in subpopulations: No
Extreme fluctuations in subpopulations: No
All individuals in one subpopulation: Yes
No. of individuals in largest subpopulation: 250-2500
Habitats and Ecology
Continuing decline in area, extent and/or quality of habitat: Yes

The IUCN Red List Partnership

The IUCN Red List of Threatened Species™ is produced and managed by the IUCN Global Species Programme, the IUCN Species Survival Commission (SSC) and The IUCN Red List Partnership.

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