Physeter macrocephalus – Sperm Whale


Peter Allinson

Regional Red List status (2016)	Vulnerable A1d*
National Red List status (2004)	Vulnerable A2bd
Reasons for change	No change
Global Red List status (2008)	Vulnerable A1d
TOPS listing (NEMBA) (2007)	None
CITES listing (1981)	Appendix I
Endemic	No

*Watch-list Data

There is an unexpected similarity between the social composition of Sperm Whales and African Elephants (*Loxodonta africana*), where the basic social unit consists of mixed adult females and their young, with mature males joining the group during the breeding season (which, in the southern hemisphere, peaks between October and December) (Whitehead 2003).

Taxonomy

Physeter macrocephalus (Linnaeus 1758)

ANIMALIA - CHORDATA - MAMMALIA - CETARTIODACTYLA - PHYSETERIDAE - *Physeter - macrocephalus*

Synonyms: *Physeter catodon* (Linnaeus 1758)

Common names: Sperm Whale, Cachelot, Pot Whale, Spermacet Whale (English), Potvis (Afrikaans)

Taxonomic status: Species

Taxonomic notes: Although *Physeter catodon* is still occasionally used in the literature, *P. macrocephalus* is recommended (Rice 1989). Both names are listed on the same page of the original description by Linnaeus (1758), and priority is unclear. However, *P. macrocephalus* is preferable because it is used much more frequently, and this will support nomenclatural stability.

Assessment Rationale

Although the population is recovering, commercial whaling in the Antarctic within the last three generations (82 years) reduced the global abundance of species significantly. As commercial whaling has ceased, the species is evaluated under the A1 criterion. Model results revealed a 6% probability for Endangered, a 54% probability of Vulnerable, and a 40% probability of Near Threatened. Thus, the species is listed as Vulnerable A1d based on historical decline in line with the global assessment. Circumpolar surveys estimate around 8,300 mature males, which is extrapolated to around 40,000 individuals in total. Within the assessment region, the historical depletion may have created a skewed sex ratio, which may make this species more vulnerable to minor threats. For example, systematic surveys from the Antarctic showed no significant population increase between 1978 and 1992. Recent modelling results corroborate the Sperm Whale's slow recovery rate, where a small decrease in adult female survivorship could lead to a declining population. Ongoing loss of mature individuals from entanglement in fishing nets and plastic ingestion could be hindering population recovery in certain areas. Furthermore, marine noise pollution may be an emerging threat that could suppress population recovery, but results are ambiguous. The effects should continue to be monitored. Overall, the overexploitation of Sperm Whales has ceased and they usually remain fairly far from anthropogenic effects due to their deep sea distribution, and the large-scale commercial fishing industry does not target major Sperm Whale food sources. However, given their historical depletion, their slow growth rate (possibly only 1% per year) and their modelled sensitivity to disturbance, current abundance and population trend estimates are urgently needed and this species should be reassessed once such data are available.

Regional population effects: Sperm Whales are highly migratory and wide-ranging. There are no barriers to dispersal, thus rescue effects are possible.

Distribution

Sperm Whales have a broad geographic range (Rice 1989), and may be present in nearly every marine region from the tropics to high latitudes. Typically they are located in deeper waters or along the continental slope, avoiding waters shallower than 300 m. Their geographic range also includes a number of enclosed or partially-enclosed areas, including both the Mediterranean and Baltic Seas, the Sea of Okhotsk and the Gulf of Mexico. Their distributions vary according to sex and size, where males have been observed closer to inshore areas than females (Best 1999). Additionally, females and their young are often restricted in their range to regions between 40°N and 40°S, while males may migrate as far as 70°N and 70°S in summer, and larger males appear to extend further north or south than smaller individuals. Sperm Whales are known to travel substantial distances, with one individual reported to have covered a straight-line distance of

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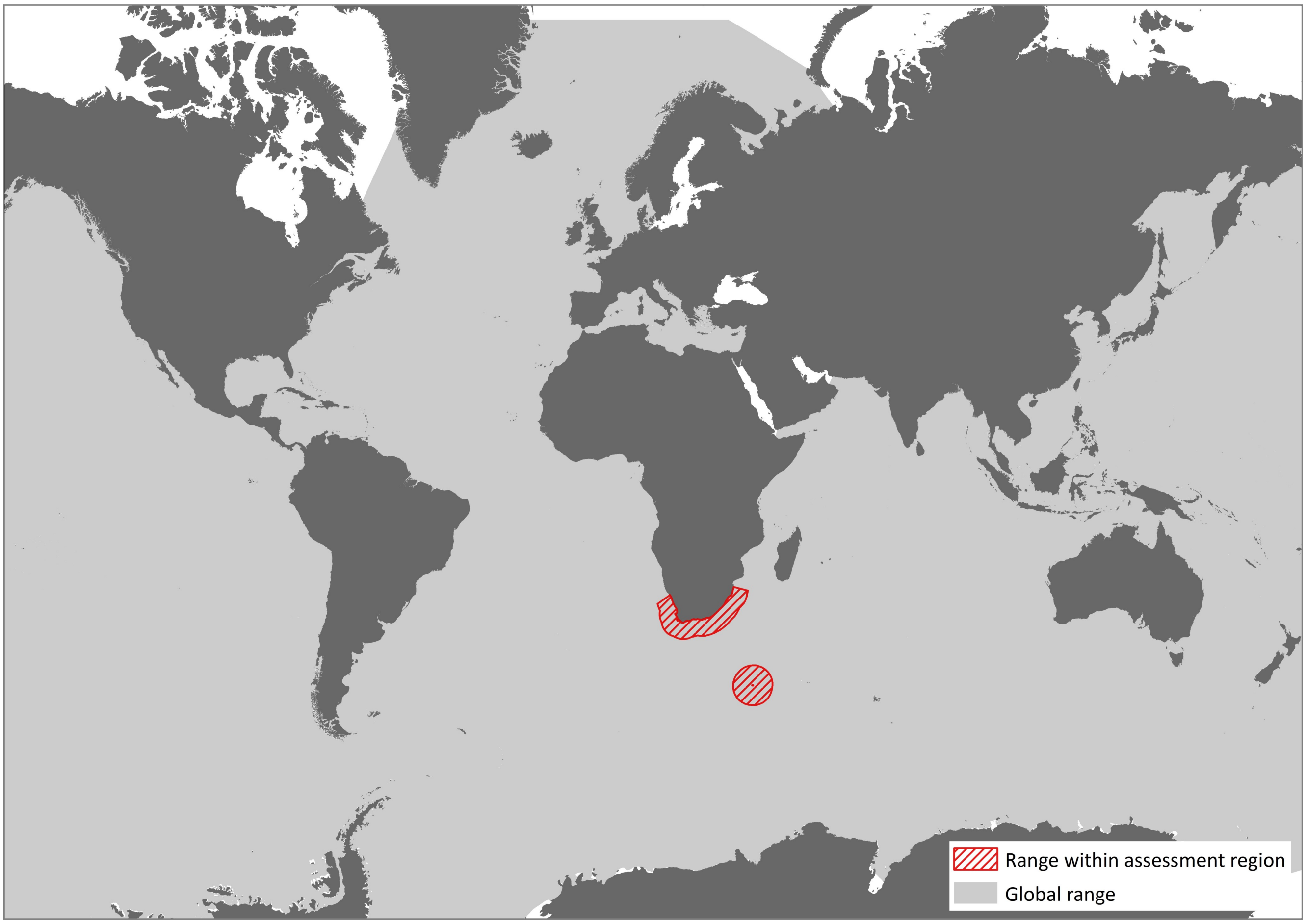

Figure 1. Distribution range for Sperm Whale (*Physeter macrocephalus*) within the assessment region (IUCN 2012)

7,400 km (Ivashin 1967). Although some overlap in geographic distribution is known to occur between northern and southern hemisphere stocks, populations are thought to be genetically isolated because seasonal breeding periods occur six months apart.

The International Whaling Commission (IWC) recognises nine Sperm Whale divisions for the southern hemisphere, which have been based more specifically on data available from commercial whaling, rather than actual biological factors (Donovan 1991). Although Sperm Whales migrate long distances, and exhibit low genetic differentiation between ocean basins (Lyrholm et al. 1999; Mesnick et al. 1999; Drouot et al. 2004a), some studies infer a high degree of geographic structure among populations across many regions (Bannister & Mitchell 1980; Kasuya & Miyashita 1988; Rendell & Whitehead 2003; Whitehead 2003). This is corroborated by recent molecular analyses that suggest females show site fidelity to coastal basins while males disperse widely for breeding (Engelhaupt et al. 2009). Within South African waters, Sperm Whales are present across the majority of the Exclusive Economic Zone (EEZ), frequently in deep waters off the west coast, and excluding shallow regions along the continental shelf. Records from Durban (30°S) and Donkergat (33°S) found that males and females reveal varied seasonality where large males were often caught in this region in spring, while juvenile males and females were more frequently caught earlier in winter.

Population

Using historical trajectories, an abundance model for global Sperm Whale populations was developed to estimate the population decline between 1700 and 1999 (Whitehead 2002). This model includes only the threat of legal commercial whaling and does not consider any other anthropogenic threats to this species, such as ship strikes, illegal whaling in the North Pacific and Antarctica, climate change, pollution, entanglement in fishing gear, or the persistent effects of social disruption and sexually-skewed population structure. These factors may limit population recovery in many areas. This model postulates that Sperm Whale populations have shown a substantial recovery since commercial whaling of this species was largely prohibited, but may, in fact, be an overestimation of current Sperm Whale recovery trends. On the other hand, some factors (such as the use of a relatively low rate of population increase) suggest that this model may result in an underestimation of population abundance. However, despite these uncertainties, this model remains the most accurate means of estimating recent population trends. The estimated global pre-exploitation population of 1.1 million Sperm Whales is thought to have declined by 29% by 1880 due to “open-boat” whaling operations, and then by 67% of the original population (to around 361,000) by the 1990s as a direct result of modern whaling (Whitehead 2002). Their global population in 1999 (10 years after the end of commercial whaling) was estimated at 32% (95% CI: 19–62%) of its original abundance, thus at approximately 352,000 individuals. Following the trajectory (used in Whitehead 2002), the model was modified slightly to extend the endpoint to 2003 (Taylor et al. 2008). This produced a population estimate in 2003 of 44% of the 1921 population. Indeed, of 1,000 model runs, 6% gave populations in 2003 of < 30% of that in 1922, 54% gave a 2003 population between 30–50% of that in 1992, and

40% suggested depletion levels of less than 50% over this time (Taylor et al. 2008). Thus, the species remains Vulnerable under the A1 criterion.

Two major global Sperm whaling operations were driven by the high commercial value attached to this species: the primitive "open-boat" hunt from 1712–1920 (Best 1983), and the modern whaling expeditions from 1910–1988 (Tønnessen & Johnsen 1982). Modern whaling operations did not, however, impact all Sperm Whale populations. For example, populations in the western North Atlantic remain at reasonably high densities, and show evidence of successful reproduction (Gordon et al. 1998). After the decline of other large rorqual species and the invention of new uses for Sperm Whale oil, commercial whaling of this species was intensified until 1964, when an annual peak of 29,255 individuals were caught. Limits imposed by the IWC after 1968 coincided with the development of synthetic alternatives for Sperm Whale oil, resulting in a decline in Sperm whaling efforts. Commercial Sperm whaling is currently prohibited by the IWC. Under special permit, only one Sperm Whale was recorded as caught in the 2009/10 season by a Japanese whaling vessel in the North Pacific (IWC unpubl. data). Although, the effect on the Sperm Whale stocks by small-scale recent operations is negligible, the value of these activities is severely questioned.

There is some concern that a few populations are still in decline, and there is no clear quantitative evidence suggesting that the global population has shown a recovery since large-scale whaling ceased in 1980 (Taylor et al. 2008). However, there is also no evidence to the contrary. Future population assessments are required to address the doubt surrounding the recovery of this species. Within the assessment region, we assume that the population is at the depleted level suggested by the global assessment, although evidence from the circumpolar surveys indicates that the population is recovering (IWC unpubl. data). However, the historical depletion may have created a skewed sex ratio, which may make this species more vulnerable to minor threats (for example, plastic pollution, ship strikes, entanglements). As such, while the Antarctic population should have repopulated from less heavily exploited breeding populations at lower latitudes following the end of large-scale commercial whaling (Taylor et al. 2008), systematic surveys of Sperm Whales in the Antarctic showed no substantial or statistically significant increase between 1978 and 1992 (Branch & Butterworth 2001). As such, we infer the population trend to be stable but current surveys are required to assess current population trends. Corroborating the empirically estimated slow recovery rate, a recent population model revealed that Sperm Whale populations grow slowly and are potentially sensitive to survivorship rates of adult females, where a slight decline in survivorship could lead to a declining population (Chiquet et al. 2013).


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Current population trend: Stable

Continuing decline in mature individuals: No

Number of mature individuals in population: *c*. 8,300 from circumpolar surveys.

Number of mature individuals in largest subpopulation: Unknown

Number of subpopulations: Unknown

Severely fragmented: No

Habitats and Ecology

With the exception of the Black Sea and probably the Red Sea, Sperm Whales occur within all major marine water bodies deeper than 1,000 m that are not covered by ice sheets (Rice 1989; Whitehead 2003). They are predominantly located in deeper waters of the open sea. However, they (especially males) may occasionally frequent shallower waters of the western North Atlantic (Scott & Sadove 1997). Females and young are most commonly limited to waters exhibiting sea surface temperatures greater than 15 °C (Rice 1989); and at latitudes lower than 40°N and 40°S. Their abundance and habitat selection usually increases with primary productivity (Jaquet et al. 1996; Rendell et al. 2004).

Sperm Whales are sexually dimorphic. Males may reach lengths of up to 18.3 m, while mature females may have a mass three times less than that of mature males, reaching lengths of 12.5 m. A 13.3 m male Sperm Whale weighed on a railway loading truck in Durban was 31,450 kg (Gambell 1970), but the heaviest recorded Sperm Whales included a male of 18.1 m at 57,000 kg and a female of 11.0 m at 24,000 kg. Sperm Whales have a substantial ecological footprint, and may consume roughly the same amount of biomass of marine resources as humans (Whitehead 2003).

Mesopelagic squid form the principal food source for Sperm Whales; however, in certain regions bottom-dwelling fish are also commonly taken (Roe 1969). In South African waters, squids with an average weight of 0.5–0.6 kg are usually consumed, while in the Antarctic, much larger squid (about 7.0 kg) are commonly preyed upon. The largest recorded squid found in the belly of a Sperm Whale was a Giant Squid (*Architeuthis* spp.) weighing 184 kg and 4.94 m long. Additional Sperm Whale food sources documented off the west coast of South Africa include crabs and tunicates (most commonly eaten by males), mysids and oilfish (more frequently eaten by females), and rays, angler fish and lancet fish (only eaten by males) (Best 1999). Adult males and females are thought to consume approximately 2% and 3% of their body mass per day, respectively. Bottom-dwelling sharks found in the stomach of a Sperm Whale collected in Durban suggest that the whale would have dived over 3,000 m deep.

The breeding season of Sperm Whales in the southern hemisphere peaks between October and December. Females usually produce calves every three or five years; however, this duration increases with age (Rice 1989). Following a gestation period of 15–16 months, one calf

Table 1. Threats to the Sperm Whale (*Physeter macrocephalus*) ranked in order of severity with corresponding evidence (based on IUCN threat categories, with regional context)

Rank	Threat description	Evidence in the scientific literature	Data quality	Scale of study	Current trend
1	*5.4.4 Fishing & harvesting Aquatic Resources*: entanglement in shark nets and fishing gear (predominantly long-line fishing operations). Current stresses *2.1 Species Mortality* and *2.2 Species Disturbance*.	Meÿer et al. 2011 Kock et al. 2006	Indirect Indirect	National Regional	Occasional entanglements in small-scale gillnets may have a negligible effect on the population, but a larger effect as a result of unregulated driftnet fisheries, and long-line fishing for Patagonian Toothfish further out to sea.
2	*9.4 Garbage & Solid Waste*: plastic bag ingestion. Current stress *2.1 Species Mortality*.	Jacobsen et al. 2010 Simmonds 2011 de Stephanis et al. 2013	Empirical Empirical Empirical	Global Global Local	Increasing. Of odontocete cetaceans, Sperm Whales are primarily and increasingly affected by the ingestion of plastic ocean debris.
3	*5.4.5 Persecution/Control*: retaliatory killings by long-line fisheries. Current stress *2.1 Species Mortality*.	-	Anecdotal	-	-
4	*4.3 Shipping Lanes*: ship strikes. Current stresses *2.1 Species Mortality* and *2.2 Species Disturbance.*	-	Anecdotal	-	-
5	*9.6.3 Noise Pollution*: energy development, seismic surveys and shipping traffic.	-	Anecdotal	-	Increasing (manageable)
6	*11.1 Habitat Shifting & Alteration*: due to climate change. Current stresses *2.3 Indirect Species Effects*: on food resources and skewed sex ratios.	MacLeod 2009	Indirect	International	Global climate change may lead to increasing sexual segregation of this species.
7	*5.4.2 Fishing & Harvesting Aquatic Resources*: historic whaling (no longer a threat). Current stress *2.3 Indirect Species Effects*: inherent small population size, reduced reproductive success, and skewed sex ratios.	Whitehead 2002	Simulation	International	The post-whaling (1990s) global population was estimated to have declined by 67% of the original pre-whaling abundance.

(about 4 m in length) is born. Solid food is consumed before the calf reaches a year old; however, the stomachs of some individuals still contained evidence of milk at ages of 7.5 years and 13 years for females and males, respectively. Sexual maturity is reached at an age of 7–13 years (lengths of 8.5 m) for females, and at around 20 years (lengths of 12.5 m) for males; however, males only reach the status of a "breeding bull" once they are around 25 years old (lengths of 13.7 m).

Ecosystem and cultural services: Marine mammals integrate and reflect ecological variation across large spatial and long temporal scales, and therefore they are prime sentinels of marine ecosystem change; migratory mysticete whales may be used to investigate broad-scale shifts in ecosystems (Moore 2008). Sperm Whales are also important reservoirs of, and vectors for, nutrients (Roman et al. 2014), thus influencing oceanic ecosystem functioning. A Sperm Whale is the main antagonist (or protagonist, depending on your point of view) in the classic novel *Moby Dick* by Herman Melville.

Use and Trade

Extensive commercial Sperm whaling has ceased, however, small-scale hunting for Sperm Whales continues in Japan and Indonesia. Under the IWC's Special Permit, 10 individuals are taken per annum by Japanese whaling fleets (Clapham et al. 2003).

Threats

Commercial whaling, historically the most substantial threat to the livelihood of this species, has ceased. Nonetheless, a range of additional factors threaten the remaining diminished populations of Sperm Whales. Considering that Sperm Whales are a large-scale migrating species, threats affecting this species in other areas of the world may impact populations that frequent the waters around South Africa, particularly those in the Atlantic, Indian and Southern Oceans. Similarly, population recovery is hindered by slow growth rates, possibly *c*. 1% per year (Whitehead 2002).

Similar to other cetaceans, Sperm Whales are vulnerable to entanglement in fishing gear, specifically gillnets, across a range of areas. This is particularly problematic in the Mediterranean Sea where Sperm Whales were one of the most commonly recorded non-target species caught in driftnets (Northridge 1991) before they were banned in 1990. Since 1990, illegal driftnet fisheries still occur in the Mediterranean but the frequency of Sperm Whale entanglements has declined considerably (Drouot et al. 2004b). Other cases of Sperm Whale entanglements have been recorded in Ecuador (Haase & Félix 1994) and California (Barlow & Cameron 2003), but are also considered to be a minor threat to this species within the assessment region. Although occasional catches in small scale gillnet fisheries are not currently expected to have a large effect on the global population, it is likely there are many more cases of Sperm Whale entanglements in

Table 2. Conservation interventions for the Sperm Whale (*Physeter macrocephalus*) ranked in order of effectiveness with corresponding evidence (based on IUCN action categories, with regional context)

Rank	Intervention description	Evidence in the scientific literature	Data quality	Scale of evidence	Demonstrated impact	Current conservation projects
1	*5.1.1 Law & Policy*: maintain hunting ban through International Whaling Commission, and continue to conduct surveys assessing the status of populations and trends in abundance.	Whitehead 2002	Simulation	International	Unsubstantiated global population estimates in 2003 have increased by approximately 121,000 since the end of commercial whaling in the 1990s.	International Whaling Commission
2	*5.4. Compliance & Enforcement*: international cooperation to restrict marine pollution.	-	Anecdotal	-	-	-
3	*4.3 Awareness & Communications*: environmental awareness of the threats associated with marine and riverine pollution.	-	Anecdotal	-	-	-

unregulated driftnet fisheries in deeper waters, which are not recorded.

Occasionally, Sperm Whales engage in an activity known as "depredation", when they actively remove fish from fishing gear (most commonly from demersal long-lines). This appears to be an increasing and risky phenomenon, which may result in entanglements, injury, death (Hucke-Gaete et al. 2004), and hostility from fishermen (including shooting of Sperm Whales) (Donoghue et al. 2003). It has been documented in a number of marine regions across the globe, including the North Atlantic, Chile, southeast Alaska, South Georgia, as well as other Southern Ocean islands and waters within the assessment region (Meÿer et al. 2011). In the Prince Edwards Islands (south of South Africa), Sperm Whales have been known to remove Patagonian Toothfish (*Dissostichus eleginoides*) from long-line fishing vessels, which occasionally results in the illegal use of dynamite or thunder flashes to deter Sperm Whales (Ashford et al. 1996; Kock et al. 2006).

The sensitivity of Sperm Whales to noise is largely unconfirmed, where studies have shown contrasting evidence of high sensitivities (Watkins et al. 1985; Bowles et al. 1994) versus little to no effects on the species (Madsen & Møhl 2000; Madsen et al. 2002). There is a lack of research investigating the long-term effects of noise, sonar and seismic surveys on Sperm Whales, and, as yet, no mortality has been observed as a result of these disturbances. On the other hand, this possible threat is increasing globally and thus the sensitivity of Sperm Whales to noise should be treated with caution.

Sexually-skewed whaling efforts may have long lasting effects on the reproductive rates (Whitehead 2003) and complex social cohesion of certain stocks, including those of the assessment region (Best 1979; Clarke et al. 1980; Whitehead et al. 1997); however, over time this inequality is likely to correct itself automatically. The population recovery and growth of Sperm Whales is fairly low, in fact, the maximum rate of increase is predicted to be around 1% per annum (Whitehead 2002). Population recovery since the end of commercial whaling, although inferred, remains purely theoretical for this species. Additionally, the severely depleted population of large, mature whales in the high latitudes of the Antarctic was assumed to have recovered from lower latitude areas where Sperm Whales were less heavily exploited following the end of commercial whaling. Contrastingly though, systematic surveys conducted for this species in the Antarctic did not reveal any significant increase between 1978 and 1992 (Branch & Butterworth 2001).

Collisions with ships impact Sperm Whales at a more regional scale, and have been specifically documented off the Canary Islands (André & Potter 2000) and in the Mediterranean (Pesante et al. 2002). Sperm Whales were listed as the most affected species by ship strikes near the island of Tenerife (Canary Islands), representing 48.8% of the total collision cases.

The ingestion of marine debris, particularly plastic, is also known to be an increasing threat to this species (Viale et al. 1992; Simmonds 2011; de Stephanis et al. 2013). In 2008, the stomachs of two Sperm Whales stranded on the coast of California were found to contain substantial quantities of plastic debris, fishing net scraps and rope (Jacobsen et al. 2010). Gastric impaction as a result of this ingested debris was the most probable cause of death for both individuals (Jacobsen et al. 2010). Walker and Coe (1990) found that Sperm Whales are primarily affected by problems associated with the ingestion of marine debris, and this may cause a specific threat within the assessment region. Sperm Whale tissues also have high levels of some contaminants (O'Shea 1999; Nielsen et al. 2000), but it is uncertain whether this has an effect on the population level.

Current habitat trend: Declining in quality due to pollution and climate change (MacLeod 2009).

Conservation

The major historic threat to Sperm Whales (commercial whaling) has largely ceased. Thus, this species seems relatively secure from this threat in the short and medium term. Sperm Whales largely avoid anthropogenic effects, as they are mostly located in deeper waters away from the coastline. Additionally, much of this species' food resources are safe from overexploitation by humans, as they feed predominantly on deep-water squid and fish in mesopelagic and benthic-pelagic habitats (Clarke 1977). This species is also listed on Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and Appendices I and II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS).

In order to reduce ship strikes, determining the distribution and population estimations of Sperm Whales in areas of high vessel traffic is required. Additionally, high speed vessels may require dedicated on-board observers in order to detect the presence of Sperm Whales and other cetaceans along the trajectory of the vessel. Finally, detailed on-board monitoring reports of cetacean collisions are essential to assess the severity of this threat to cetacean populations within the assessment region.

There have been a number of legislative interventions to limit marine pollution. A key intervention is the 1978 Protocol to the International Convention for the Prevention of Pollution from Ships (MARPOL), which acknowledges that ships add a significant and manageable quantity of pollution into marine environments (Lentz 1987). Annex V of MARPOL aims to "restrict at sea discharge of garbage and bans at sea disposal of plastics and other synthetic materials such as ropes, fishing nets, and plastic garbage bags with limited exceptions". Nevertheless, this legislation is largely ignored and Clarke (1977) estimated that 6.5 million tons of plastic is discarded into the ocean each year. Enforcement and international cooperation is essential to ensure that all marine vessels comply with the Annex V policy.

Education and community involvement is also a powerful tool with which to approach the threat of marine (particularly plastic) pollution. Considering that land-based pollution usually ends up in the ocean, awareness, education and terrestrial-based action is often more effective in mitigating the problem compared to the development of addition legislative policies (for example, Ross & Swanson 1994).

Recommendations for managers and practitioners:

- Systematic monitoring: design and implement a monitoring programme (acoustic and sightings) that can detect population size and trends. For example, by using the recently developed single nucleotide polymorphism markers (Morin et al. 2007).
- Develop best practice guidelines for seismic surveys and enforce regulations.

Research priorities:

- Population size and trends. Given the long and deep diving behaviour of male Sperm Whales, the global estimate is almost certain to be an underestimate, as it is based on a sighting survey.
- Effects of marine noise pollution on Sperm Whale populations.
- Understanding the effects of minor threats (pollution, ship strikes, entanglements etc.) to this species, as well as the rates and trends associated with population recovery.

Encouraged citizen actions:

- Whale-watching operators could contribute to photo-ID catalogues and behavioural observations.
- Report strandings to relevant authorities.
- Participate as volunteers in Sperm Whale research projects.
- Avoid using plastic bags, participate in beach and river clean-up initiatives, and raise awareness of the environmental threats associated with marine and terrestrial litter.

Data Sources and Quality

Table 3. Information and interpretation qualifiers for the Sperm Whale (*Physeter microcephalus*) assessment

Data sources	Field study (unpublished – circumpolar surveys IWC, whaling records; literature), indirect information (literature)
Data quality (max)	Estimated
Data quality (min)	Inferred
Uncertainty resolution	Confidence intervals
Risk tolerance	Evidentiary

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Details of the methods used to make this assessment can be found in *Mammal Red List 2016: Introduction and Methodology.*