Sperm whale

The **sperm whale** or **cachalot**[a] (*Physeter macrocephalus*) is the largest of the toothed whales and the largest toothed predator. It is the only living member of the genus *Physeter* and one of three extant species in the sperm whale family, along with the pygmy sperm whale and dwarf sperm whale of the genus *Kogia*.

The sperm whale is a pelagic mammal with a worldwide range, and will migrate seasonally for feeding and breeding.[5] Females and young males live together in groups, while mature males (bulls) live solitary lives outside of the mating season. The females cooperate to protect and nurse their young. Females give birth every four to twenty years, and care for the calves for more than a decade. A mature sperm whale has few natural predators, although calves and weakened adults are sometimes killed by pods of killer whales (orcas).

Mature males average 16 metres (52 ft) in length but some may reach 20.7 metres (68 ft), with the head representing up to one-third of the animal's length. Plunging to 2,250 metres (7,382 ft), it is the third deepest diving mammal, exceeded only by the southern elephant seal and Cuvier's beaked whale.[6][7] The sperm whale uses echolocation and vocalization as loud as 230 decibels (re 1 µPa m) underwater.[8] It has the largest brain on Earth, more than five times heavier than a human's. Sperm whales can live 70 years or more.[9][10][11]

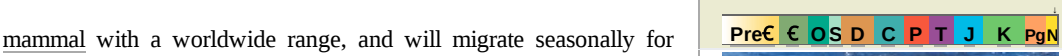
Spermaceti (sperm oil), from which the whale derives its name, was a prime target of the whaling industry, and was sought after for use in oil lamps, lubricants, and candles. Ambergris, a solid waxy waste product sometimes present in its digestive system, is still highly valued as a fixative in perfumes, among other uses. Beachcombers look out for ambergris as flotsam.[12] Sperm whaling was a major industry in the 19th century, depicted in the novel *Moby-Dick*. The species is protected by the International Whaling Commission moratorium, and is listed as vulnerable by the International Union for Conservation of Nature.

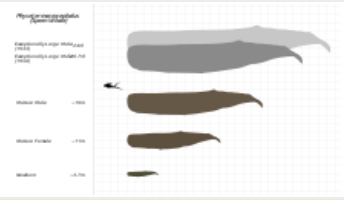
Contents

Sperm whale[1]

Temporal range: Pliocene – Recent

[2]





Conservation status

Vulnerable (IUCN 3.1)[3]

Endangered (IUCN 3.1)[4]

(Mediterranean)

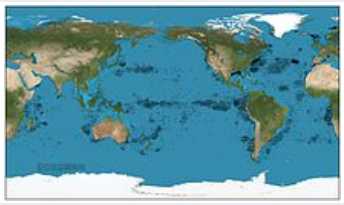
Scientific classification

Kingdom:	Animalia
Phylum:	Chordata
Class:	Mammalia
Order:	Artiodactyla
Infraorder:	Cetacea
Family:	Physeteridae
Genus:	*Physeter* Linnaeus, 1758
Species:	***P. macrocephalus***

Binomial name

Physeter macrocephalus

Linnaeus, 1758



Major sperm whale grounds

Synonyms

- *Physeter catodon* Linnaeus, 1758
- *Physeter microps* Linnaeus, 1758
- *Physeter tursio* Linnaeus, 1758
- *Physeter australasianus* Desmoulins, 1822

Taxonomy and naming

Etymology

The name *sperm whale* is a truncation of *spermaceti whale*. Spermaceti, originally mistakenly identified as the whales' semen, is the semi-liquid, waxy substance found within the whale's head (see below).[13] The sperm whale is also known as the "cachalot", which is thought to derive from the archaic French for "tooth" or "big teeth", as preserved for example in *caishau* in the Gascon dialect (a word of either Romance[14] or Basque[15] origin). The etymological dictionary of Corominas says the origin is uncertain, but it suggests that it comes from the Vulgar Latin *cappula*, plural of *cappulum*, "sword hilt".[16] The word *cachalot* came to English via French from Spanish or Portuguese *cachalote*, perhaps from Galician/Portuguese *cachola*, "big head".[17] The term is retained in the Russian word for the animal, кашалот (*kashalot*), as well as in many other languages.

The scientific genus name *Physeter* comes from the Greek *physētēr* (φυσητήρ), meaning "blowpipe, blowhole (of a whale)", or – as a *pars pro toto* – "whale". The specific name *macrocephalus* is Latinized from the Greek *makrokephalos* (μακροκέφαλος, meaning "big-headed"), from *makros* (μακρός, "large") + *kephalē* (κεφαλή, "head").

Its synonymous specific name *catodon* means "down-tooth", from the Greek elements *cat(a)-* ("below") and *odṓn* ("tooth"); so named because it has visible teeth only in its lower jaw.[18] (See: Teeth) Another synonym *australasianus* ("Australasian") was applied to sperm whales in the Southern Hemisphere.[19]

Taxonomy

The sperm whale belongs to the order Cetartiodactyla,[20][21][22][23][24] the order containing all cetaceans and even-toed ungulates. It is a member of the unranked clade Cetacea, with all the whales, dolphins, and porpoises, and further classified into Odontoceti, containing all the toothed whales and dolphins. It is the sole extant species of its genus, *Physeter*, in the family Physeteridae. Two species of the related extant genus *Kogia*, the pygmy sperm whale *Kogia breviceps* and the dwarf sperm whale *K. sima*, are placed either in this family or in the family Kogiidae.[25] In some taxonomic schemes the families Kogiidae and Physeteridae are combined as the superfamily Physeteroidea (see the separate entry on the sperm whale family).[26]

Swedish ichthyologist Peter Artedi described it as *Physeter catodon* in his 1738 work *Genera piscium*, from the report of a beached specimen in the Orkneys in 1693 and two beached in the Netherlands in 1598 and 1601.[27] The 1598 specimen was near Berkhey.

The sperm whale is one of the species originally described by Carl Linnaeus in his landmark 1758 10th edition of *Systema Naturae*. He recognised four species in the genus *Physeter*.[28] Experts soon realised that just one such species exists, although there has been debate about whether this should be named *P. catodon* or *P. macrocephalus*, two of the names used by Linnaeus. Both names are still used, although most recent authors now accept *macrocephalus* as the valid name, limiting *catodon*'s status to a lesser synonym. Until 1974, the species was generally known as *P. catodon*. In that year, however, Dutch zoologists Antonius M. Husson and Lipke Holthuis proposed that the correct name should be *P. macrocephalus*, the second name in the genus *Physeter* published by Linnaeus concurrently with *P. catodon*. This proposition was based on the grounds that the names were synonyms published simultaneously, and, therefore, the ICZN Principle of the First Reviser should apply. In this instance, it led to the choice of *P. macrocephalus* over *P. catodon*, a view re-stated in Holthuis, 1987.[29] This has been adopted by most subsequent authors, although Schevill (1986[30] and 1987[31]) argued that *macrocephalus* was published with an inaccurate description and that therefore only the species *catodon* was valid, rendering the principle of "First Reviser" inapplicable. The most recent version of ITIS has altered its usage from *P. catodon* to *P. macrocephalus*,[32] following L. B. Holthuis and more recent (2008) discussions with relevant experts.[33][34] Furthermore, The Taxonomy Committee of the Society for Marine Mammalogy, the largest international association of marine mammal scientists in the world, officially uses *Physeter macrocephalus* when publishing their definitive list of marine mammal species.[35]

Biology

External appearance

Average sizes[9]

	Length	Weight
Male	16 metres (52 ft)	41 tonnes (45 short tons)
Female	11 metres (36 ft)	14 tonnes (15 short tons)
Newborn	4 metres (13 ft)	1 tonne (1.1 short tons)

The sperm whale is the largest toothed whale, with adult males measuring up to 20.7 metres (68 ft) long and weighing up to 80 tonnes (79 long tons; 88 short tons).[36][37][38] By contrast, the second largest toothed whale (Baird's beaked whale) measures 12.8 metres (42 ft) and weighs up to 14 tonnes (15 short tons).[39]

The sperm whale is among the most sexually dimorphic of all cetaceans. At birth both sexes are about the same size,[9] but mature males are typically 30% to 50% longer and three times as massive as females.[40] Newborn sperm whales are usually between 3.7 to 4.3 meters (12 to 14 ft) long in length.[41] Female sperm whales are physically mature at about 10.6 to 11 meters (35 to 36 ft) in length and generally don't grow much larger than about 12 metres (39 ft). Male sperm whales are physically mature at about 16 metres (52 ft) in length and generally reaching a maximum of about 18 to 19 meters (59 to 62 ft).[9][38][36][42][43][44]

There are old reports of sperm whales approaching, reaching or exceeding 80 feet (24 m) in length but there is disagreement as to the accuracy of these claims which are often considered exaggerations or as being measured along the curves of the body.[36][38][44] The whale that sank the *Essex* (one of the incidents behind *Moby-Dick*) was claimed to be 26 metres (85 ft).[44] The Nantucket Whaling Museum has a 5.5 metres (18 ft)-long jawbone; the museum claims that this individual was 24 metres (80 ft) long. A 5 metres (16 ft) long jawbone is held in the British Natural History Museum and a 4.7 metres (15 ft) long jawbone is held in the Oxford University Museum of Natural History.[36] In 1853, one sperm whale was reported at 62 feet (19 m) in length with a head measuring 20 feet (6.1 m).[45]

The largest animal weighed in whole was a sperm whale which measured 18 metres (59 ft) long and weighed 53 tonnes (52 long tons; 58 short tons).[36] The largest sperm whale weighed in piecemeal was 18.1 metres (59 ft) long and weighed 57 tonnes (56 long tons; 63 short tons).[37] An individual measuring 20.7 metres (68 ft) was reported from a Soviet whaling fleet near the Kuril Islands in 1950 and is cited by some authors as the largest accurately measured. It has been estimated to weigh 80 tonnes (79 long tons; 88 short tons).[36][37][38] In a review of size variation in marine megafauna, McClain and colleagues noted that the International Whaling Commission's largest recorded male was 24 metres (79 ft) in 1933, which they supported as the largest. However, sizes like these are rare, with 95% of recorded sperm whales below 15.85 metres (52.0 ft).[38]

Extensive whaling may have decreased their size, as males were highly sought, primarily after World War II.[46] Today, males do not usually exceed 18.3 metres (60 ft) in length or 51 tonnes (50 long tons; 56 short tons) in weight.[9] Another view holds that exploitation by overwhaling had virtually no effect on the size of the bull sperm whales, and their size may have actually increased in current times on the basis of density dependent effects.[47] Old males taken at Solander Islands were recorded to be extremely large and unusually rich in blubbers.[48]

The sperm whale's unique body is unlikely to be confused with any other species. The sperm whale's distinctive shape comes from its very large, block-shaped head, which can be one-quarter to one-third of the animal's length. The S-shaped blowhole is located very close to the front of the head and shifted to the whale's left.[40] This gives rise to a distinctive bushy, forward-angled spray.

Unusual among cetaceans, the sperm whale's blowhole is highly skewed to the left side of the head.

The sperm whale's flukes (tail lobes) are triangular and very thick. Proportionally, they are larger than that of any other cetacean, and are very flexible.[49] The whale lifts its flukes high out of the water as it begins a feeding dive.[40] It has a series of ridges on the back's caudal third instead of a dorsal fin. The largest ridge was called the 'hump' by whalers, and can be mistaken for a dorsal fin because of its shape and size.[9]

In contrast to the smooth skin of most large whales, its back skin is usually wrinkly and has been likened to a prune by whale-watching enthusiasts.[50] Albinos have been reported.[10][51][52]

Skeleton

A sperm whale skeleton

The ribs are bound to the spine by flexible cartilage, which allows the ribcage to collapse rather than snap under high pressure.[53] While sperm whales are well adapted to diving, repeated dives to great depths have long-term effects. Bones show the same pitting that signals decompression sickness in humans. Older skeletons showed the most extensive pitting, whereas calves showed no damage. This damage may indicate that sperm whales are susceptible to decompression sickness, and sudden surfacing could be lethal to them.[54]

Like that of all cetaceans, the spine of the sperm whale has reduced zygapophysial joints, of which the remnants are modified and are positioned higher on the vertebral dorsal spinous process, hugging it laterally, to prevent extensive lateral bending and facilitate more dorso-ventral bending. These evolutionary modifications make the spine more flexible but weaker than the spines of terrestrial vertebrates.[55]

Like many cetaceans, the sperm whale has a vestigial pelvis that is not connected to the spine.

Like that of other toothed whales, the skull of the sperm whale is asymmetrical so as to aid echolocation. Sound waves that strike the whale from different directions will not be channeled in the same way.[56] Within the basin of the cranium, the openings of the bony narial tubes (from which the nasal passages spring) are skewed towards the left side of the skull.

Labeled sperm whale skeleton

Jaws and teeth

The sperm whale's lower jaw is very narrow and underslung.[57] The sperm whale has 18 to 26 teeth on each side of its lower jaw which fit into sockets in the upper jaw.[57] The teeth are cone-shaped and weigh up to 1 kilogram (2.2 lb) each.[58] The teeth are functional, but do not appear to be necessary for capturing or eating squid, as well-fed animals have been found without teeth or even with deformed jaws. One hypothesis is that the teeth are used in aggression between males.[59] Mature males often show scars which seem to be caused by the teeth. Rudimentary teeth are also present in the upper jaw, but these rarely emerge into the mouth.[60] Analyzing the teeth is the preferred method for determining a whale's age. Like the age-rings in a tree, the teeth build distinct layers of cementum and dentine as they grow.[61]

Sperm whale tooth

Brain

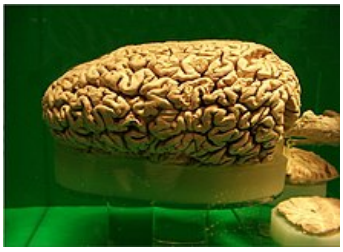
The sperm whale brain is the largest known of any modern or extinct animal, weighing on average about 7.8 kilograms (17 lb)[62][63] (with the smallest known weighing 6.4 kilograms (14 lb) and the largest known weighing 9.2 kilograms (20 lb)),[36][37] more than five times heavier than a human's, and has a volume of about 8,000 cm^3.[64] Although larger brains generally correlate with higher intelligence, it is not the only factor. Elephants and dolphins also have larger brains than humans.[65] The sperm whale has a lower encephalization quotient than many other whale and dolphin species, lower than that of non-human anthropoid apes, and much lower than humans'.[63][66]

The sperm whale's cerebrum is the largest in all mammalia, both in absolute and relative terms. The olfactory system is reduced, suggesting that the sperm whale has a poor sense of taste and smell. By contrast, the auditory system is enlarged. The pyramidal tract is poorly developed, reflecting the reduction of its limbs.[67]

The lower jaw is long and narrow. The teeth fit into sockets along the upper jaw. (*lifelike sculpture*)

Biological systems

The sperm whale respiratory system has adapted to cope with drastic pressure changes when diving. The flexible ribcage allows lung collapse, reducing nitrogen intake, and metabolism can decrease to conserve oxygen.[68][69] Between dives, the sperm whale surfaces to breathe for about eight minutes before diving again.[40] Odontoceti (toothed whales) breathe air at the surface through a single, S-shaped blowhole, which is extremely skewed to the left. Sperm whales spout (breathe) 3–5 times per minute at rest, increasing to 6–7 times per minute after a dive. The blow is a noisy, single stream that rises up to 2 metres (6.6 ft) or more above the surface and points forward and left at a 45° angle.[70] On average, females and juveniles blow every 12.5 seconds before dives, while large males blow every 17.5 seconds before dives.[71] A sperm whale killed 160 km (100 mi) south of Durban, South Africa, after a 1-hour, 50-minute dive was found with two dogfish (Scymnodon sp.), usually found at the sea floor, in its belly.[72]



The sperm whale's brain is the largest in the world, five times heavier than a human's.

The sperm whale has the longest intestinal system in the world,[73] exceeding 300 m in larger specimens.[74][75] Similar to ruminants the sperm whale has a four-chambered stomach. The first secretes no gastric juices and has very thick muscular walls to crush the food (since whales cannot chew) and resist the claw and sucker attacks of swallowed squid. The second chamber is larger and is where digestion takes place. Undigested squid beaks accumulate in the second chamber – as many as 18,000 have been found in some dissected specimens.[74][76][77] Most squid beaks are vomited by the whale, but some occasionally make it to the hindgut. Such beaks precipitate the formation of ambergris.[77]

The arterial system of a sperm whale foetus

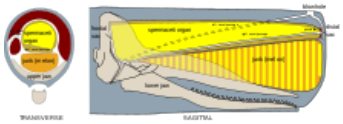
In 1959, the heart of a 22 metric-ton (24 short-ton) male taken by whalers was measured to be 116 kilograms (256 lb), about 0.5% of its total mass.[78] The circulatory system has a number of specific adaptations for the aquatic environment. The diameter of the aortic arch increases as it leaves the heart. This bulbous expansion acts as a windkessel, ensuring a steady blood flow as the heart rate slows during diving.[79] The arteries that leave the aortic arch are positioned symmetrically. There is no costocervical artery. There is no direct connection between the internal carotid artery and the vessels of the brain.[80] Their circulatory system has adapted to dive at great depths, as much as 2,250 metres (7,382 ft)[6][7][81][82][83] for up to 120 minutes.[84] More typical dives are around 400 metres (1,310 ft) and 35 minutes in duration.[40] Myoglobin, which stores oxygen in muscle tissue, is much more abundant than in terrestrial animals.[85] The blood has a high density of red blood cells, which contain oxygen-carrying haemoglobin. The oxygenated blood can be directed towards only the brain and other essential

organs when oxygen levels deplete.[86][87][88] The spermaceti organ may also play a role by adjusting buoyancy (see below).[89] The arterial retia mirabilia are extraordinarily well-developed. The complex arterial retia mirabilia of the sperm whale are more extensive and larger than those of any other cetacean.[80]

Senses

Spermaceti organ and melon

Atop the whale's skull is positioned a large complex of organs filled with a liquid mixture of fats and waxes called spermaceti. The purpose of this complex is to generate powerful and focused clicking sounds, which the sperm whale uses for echolocation and communication.[90][91][92][93][94][95][96][97][98][99][100]



Anatomy of the sperm whale's head. The organs above the jaw are devoted to sound generation.

The spermaceti organ is like a large barrel of spermaceti. Its surrounding wall, known as the *case*, is extremely tough and fibrous. The case can hold within it up to 1,900 litres of spermaceti.[101] It is proportionately larger in males.[102] This oil is a mixture of triglycerides and wax esters. The proportion of wax esters in the spermaceti organ increases with the age of the whale: 38–51% in calves, 58–87% in adult females, and 71–94% in adult males.[103] The spermaceti at the core of the organ has a higher wax content than the outer areas.[104] The speed of sound in spermaceti is 2,684 m/s (at 40 kHz, 36 °C), making it nearly twice as fast as in the oil in a dolphin's melon.[105]

Below the spermaceti organ lies the "junk" which consists of compartments of spermaceti separated by cartilage. It is analogous to the melon found in other toothed whales.[106] The structure of the junk redistributes physical stress across the skull and may have evolved to protect the head during ramming.[107][108][106]

Running through the head are two air passages. The left passage runs alongside the spermaceti organ and goes directly to the blowhole, whilst the right passage runs underneath the spermaceti organ and passes air through a pair of phonic lips and into the distal sac at the very front of the nose. The distal sac is connected to the blowhole and the terminus of the left passage. When the whale is submerged, it can close the blowhole, and air that passes through the phonic lips can circulate back to the lungs. The sperm whale, unlike other odontocetes, has only one pair of phonic lips, whereas all other toothed whales have two,[109] and it is located at the front of the nose instead of behind the melon.

At the posterior end of this spermaceti complex is the frontal sac, which covers the concave surface of the cranium. The posterior wall of the frontal sac is covered with fluid–filled knobs, which are about 4–13 mm in diameter and separated by narrow grooves. The anterior wall is smooth. The knobbly surface reflects sound waves that come through the spermaceti organ from the phonic lips. The grooves between the knobs trap a film of air that is consistent whatever the orientation or depth of the whale, making it an excellent sound mirror.[105]

The spermaceti organs may also help adjust the whale's buoyancy. It is hypothesized that before the whale dives, cold water enters the organ, and it is likely that the blood vessels constrict, reducing blood flow, and, hence, temperature. The wax therefore solidifies and reduces in volume.[89][110] The increase in specific density generates a down force of about 392 newtons (88 lb_f) and allows the whale to dive with less effort. During the hunt, oxygen consumption, together with blood vessel dilation, produces heat and melts the spermaceti, increasing its buoyancy and enabling easy surfacing.[111] However, more recent work[94] has found many problems with this theory including the lack of anatomical structures for the actual heat exchange.[112] Another issue is that if the spermaceti does indeed cool and solidify, it would affect the whale's echolocation ability just when it needs it most (for hunting in the depths).

Herman Melville's fictional story *Moby-Dick* suggests that the "case" containing the spermaceti serves as a battering ram for use in fights between males.[113] A few famous instances include the well-documented sinking of the ships *Essex* and *Ann Alexander* by attackers estimated to weigh only one-fifth as much as the ships.[106]

The phonic lips.

The frontal sac, exposed. Its surface is covered with fluid-filled knobs.

A piece of the posterior wall of the frontal sac. The grooves between the knobs trap a consistent film of air, making it an excellent sound mirror.[105]

Eyes and vision

Play media

Like other toothed whales, the sperm whale can retract its eyes.

The sperm whale's eye does not differ greatly from those of other toothed whales except in size. It is the largest among the toothed whales, weighing about 170 g. It is overall ellipsoid in shape, compressed along the visual axis, measuring about 7×7×3 cm. The cornea is elliptical and the lens is spherical. The sclera is very hard and thick, roughly 1 cm anteriorly and 3 cm posteriorly. There are no ciliary muscles. The choroid is very thick and contains a fibrous *tapetum lucidum*. Like other toothed whales, the sperm whale can retract and protrude its eyes, thanks to a 2-cm-thick retractor muscle attached around the eye at the equator,[114] but are unable to roll the eyes in their sockets.[115]

According to Fristrup and Harbison (2002),[116] sperm whale's eyes afford good vision and sensitivity to light. They conjectured that sperm whales use vision to hunt squid, either by detecting silhouettes from below or by detecting bioluminescence. If sperm whales detect silhouettes, Fristrup and Harbison suggested that they hunt upside down, allowing them to use the forward parts of the ventral visual fields for binocular vision.

Sleeping

For some time researchers have been aware that pods of sperm whales may sleep for short periods, assuming a vertical position with their heads just below or at the surface. A 2008 study published in *Current Biology* recorded evidence that whales may sleep with both sides of the brain. It appears that some whales may fall into a deep sleep for about 7 percent of the time, most often between 6 p.m. and midnight.[117]

Genetics

Sperm whales have 21 pairs of chromosomes (2n=42).[118] The genome of live whales can be examined by recovering shed skin.[119]

Vocalization complex

Capable of emitting sounds at a volume of 230 decibels—more than an airplane jet engine at takeoff—the sperm whale is the loudest animal in the world.[120] Sperm whale vocalization is a learned behavior that is clan specific.[121]

0:00 / 0:00

Sperm whale vocalization

Mechanism

When echolocating, the sperm whale emits a directionally focused beam of broadband clicks. Clicks are generated by forcing air through a pair of phonic lips (also known as "monkey lips" or "museau de singe") at the front end of the nose, just below the blowhole. The sound then travels backwards along the length of the nose through the spermaceti organ. Most of the sound energy is then reflected off the frontal sac at the cranium and into the melon, whose lens-like structure focuses it.[91][92][93][94][95][96][97][98] Some of the sound will reflect back into the spermaceti organ and back towards the front of the whale's nose, where it will be reflected through the spermaceti organ a third time. This back and forth reflection which happens on the scale of a few milliseconds creates a multi-pulse click structure.[122] This multi-pulse click structure allows researchers to measure the whale's spermaceti organ using only the sound of its clicks.[123][124] Because the interval between pulses of a sperm whale's click is related to the length of the sound producing organ, an individual whale's click is unique to that individual. However, if the whale matures and the size of the spermaceti organ increases, the tone of the whale's click will also change.[124] The lower jaw is the primary reception path for the echoes. A continuous fat-filled canal transmits received sounds to the inner ear.[125]

The source of the air forced through the phonic lips is the right nasal passage. While the left nasal passage opens to the blow hole, the right nasal passage has evolved to supply air to the phonic lips. It is thought that the nostrils of the land-based ancestor of the sperm whale migrated through evolution to their current functions, the left nostril becoming the blowhole and the right nostril becoming the phonic lips.[126]

Air that passes through the phonic lips passes into the distal sac, then back down through the left nasal passage. This recycling of air allows the whale to continuously generate clicks for as long as it is submerged.[127]

Types of vocalization

A creak is a rapid series of high-frequency clicks that sounds somewhat like a creaky door hinge. It is typically used when homing in on prey.[128]

A coda is a short pattern of 3 to 20 clicks that is used in social situations. They were once thought to be a way by which individuals identified themselves, but individuals have been observed producing multiple codas, and the same codas are used by multiple individuals.[129] However, each click contains a physical signature which suggests that clicks can be used to identify individuals.[90] Geographically separate pods exhibit distinct dialects.[130] Large males are generally solitary and rarely produce codas.[129] In breeding grounds, codas are almost entirely produced by adult females. Despite evidence that sperm whales share similar codas, it is still unknown whether sperm whales possess individually specific coda repertoires or whether individuals make codas at different rates.[131]

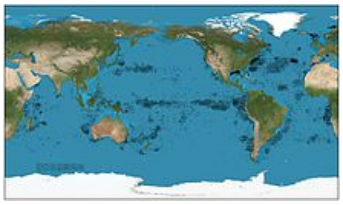
Slow clicks are heard only in the presence of males (it is not certain whether females occasionally make them). Males make a lot of slow clicks in breeding grounds (74% of the time), both near the surface and at depth, which suggests they are primarily mating signals. Outside breeding grounds, slow clicks are rarely heard, and usually near the surface.[132]

Characteristics of sperm whale clicks[128]

Click type	Apparent source level (dB re 1 µPa m])	Directionality	Centroid frequency (kHz)	Inter-click interval (s)	Duration of click (ms)	Duration of pulse (ms)	Range audible to sperm whale (km)	Inferred function	Audio sample
Usual	230	High	15	0.5–1.0	15–30	0.1	16	Searching for prey	0:00 / 0:00
Creak	205	High	15	0.005–0.1	0.1–5	0.1	6	Homing in on prey	0:00 / 0:00
Coda	180	Low	5	0.1–0.5	35	0.5	~2	Social communication	0:00 / 0:00
Slow	190	Low	0.5	5–8	30	5	60	Communication by males	0:00 / 0:00

Ecology

Distribution



Global concentrations of sperm whales

Sperm whales are among the most cosmopolitan species. They prefer ice-free waters over 1,000 metres (3,300 ft) deep.[3] Although both sexes range through temperate and tropical oceans and seas, only adult males populate higher latitudes.[10] Among several regions, such as along coastal waters of southern Australia, sperm whales have been considered to be locally extinct.[133]

They are relatively abundant from the poles to the equator and are found in all the oceans. They inhabit the Mediterranean Sea, but not the Black Sea,[9] while their presence in the Red Sea is uncertain.[3] The shallow entrances to both the Black Sea and the Red Sea may account for their absence.[134] The Black Sea's lower layers are also anoxic and contain high concentrations of sulphur compounds such as hydrogen sulphide.[135] The first ever sighting in Pakistan was made in 2017.[136][137] The first ever record on the west coast of the Korean Peninsula (Yellow Sea) was made in 2005.[138][139] followed by one on Ganghwa Island in 2009.[140]

Populations are denser close to continental shelves and canyons.[10] Sperm whales are usually found in deep, off-shore waters, but may be seen closer to shore, in areas where the continental shelf is small and drops quickly to depths of 310 to 920 metres (1,020 to 3,020 ft).[9] Coastal areas with significant sperm whale populations include the Azores and Dominica.[141] In Asian waters, whales are also observed regularly in coastal waters in places such as the Commander and Kuril Islands, Shiretoko Peninsula which is one of few locations where whales can be observed from shores,[142] off Kinkasan, vicinity to Tokyo Bay[143] and the Bōsō Peninsula to the Izu[144][145] and the Izu Islands, the Volcano Islands, Yakushima and the Tokara Islands to the Ryukyu Islands,[146][147]Taiwan, the Northern Mariana Islands,[148] and so forth. Historical catch records suggest there could have been smaller aggression grounds in the Sea of Japan as well.[149] Along the Korean Peninsula, the first confirmed observation within the Sea of Japan, eight animals off Guryongpo, was made in 2004 since after the last catches of five whales off Ulsan in 1911,[139][150] while nine whales were observed in the East China Sea side of the peninsula in 1999.[151]

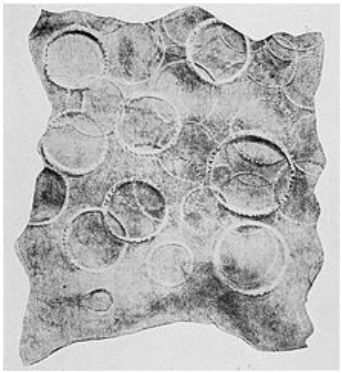
Grown males are known to enter surprisingly shallow bays to rest (whales will be in state of rest during these occasions). There are unique, coastal groups reported from various areas among the globe such as Scotland,[152] and Shiretoko Peninsula, off Kaikoura, in the Davao Gulf. Such coastal groups were more abundant in pre-whaling days.[153]

Genetic analysis indicates that the world population of sperm whales originated in the Pacific Ocean from a population of about 10,000 animals around 100,000 years ago, when expanding ice caps blocked off their access to other seas. In particular, colonization of the Atlantic was revealed to have occurred multiple times during this expansion of their range.[154]

Diet

Sperm whales usually dive between 300 to 800 metres (980 to 2,620 ft), and sometimes 1 to 2 kilometres (3,300 to 6,600 ft), in search of food.[155] Such dives can last more than an hour.[155] They feed on several species, notably the giant squid, but also the colossal squid, octopuses, and fish such as demersal rays, but their diet is mainly medium-sized squid.[156] Some prey may be taken accidentally while eating other items.[156] Most of what is known about deep-sea squid has been learned from specimens in captured sperm whale stomachs, although

more recent studies analysed faeces. One study, carried out around the Galápagos, found that squid from the genera *Histioteuthis* (62%), *Ancistrocheirus* (16%), and *Octopoteuthis* (7%) weighing between 12 and 650 grams (0.026 and 1.433 lb) were the most commonly taken.[157] Battles between sperm whales and giant squid or colossal squid have never been observed by humans; however, white scars are believed to be caused by the large squid. One study published in 2010 collected evidence that suggests that female sperm whales may collaborate when hunting Humboldt squid.[158] Tagging studies have shown that sperm whales hunt upside down at the bottom of their deep dives. It is suggested that the whales can see the squid silhouetted above them against the dim surface light.[159]


A piece of sperm whale skin with giant squid sucker scars

An older study, examining whales captured by the New Zealand whaling fleet in the Cook Strait region, found a 1.69:1 ratio of squid to fish by weight.[160] Sperm whales sometimes take sablefish and toothfish from long lines. Long-line fishing operations in the Gulf of Alaska complain that sperm whales take advantage of their fishing operations to eat desirable species straight off the line, sparing the whales the need to hunt.[161] However, the amount of fish taken is very little compared to what the sperm whale needs per day. Video footage has been captured of a large male sperm whale "bouncing" a long line, to gain the fish.[162] Sperm whales are believed to prey on the megamouth shark, a rare and large deep-sea species discovered in the 1970s.[163] In one case, three sperm whales were observed attacking or playing with a megamouth.[164]

Sperm whales have also been noted to feed on bioluminescent pyrosomes such as *Pyrosoma atlanticum*.[165][166][167] It is thought that the foraging strategy of sperm whales for bioluminescent squids may also explain the presence of these light-emitting pyrosomes in the diet of the sperm whale.[167]

The sharp beak of a consumed squid lodged in the whale's intestine may lead to the production of ambergris, analogous to the production of pearls in oysters.[168] The irritation of the intestines caused by squid beaks stimulates the secretion of this lubricant-like substance. Sperm whales are prodigious feeders and eat around 3% of their body weight per day. The total annual consumption of prey by sperm whales worldwide is estimated to be about 91 million tonnes (100 million short tons).[169] In comparison, human consumption of seafood is estimated to be 115 million tonnes (127 million short tons).[170]


Ambergris

Sperm whales hunt through echolocation. Their clicks are among the most powerful sounds in the animal kingdom (see above). It has been hypothesised that it can stun prey with its clicks. Experimental studies attempting to duplicate this effect have been unable to replicate the supposed injuries, casting doubt on this idea.[171]

It has been stated that sperm whales, as well as other large cetaceans, help fertilise the surface of the ocean by consuming nutrients in the depths and transporting those nutrients to the oceans' surface when they defecate, an effect known as the whale pump.[172] This fertilises phytoplankton and other plants on the surface of the ocean and contributes to ocean productivity and the drawdown of atmospheric carbon.[173]

Life cycle

Sperm whales can live 70 years or more.[9][10][11] They are a prime example of a species that has been K-selected, meaning their reproductive strategy is associated with stable environmental conditions and comprises a low birth rate, significant parental aid to offspring, slow maturation, and high longevity.[40]

How they choose mates has not been definitively determined. Bulls will fight with each other over females, and males will mate with multiple females, making them polygynous, but they do not dominate the group as in a harem.[174][175] Bulls do not provide paternal care to their offspring but rather play a fatherly role to younger bulls to show dominance.[176]

Females become fertile at around 9 years of age.[177] The oldest pregnant female ever recorded was 41 years old.[178] Gestation requires 14 to 16 months, producing a single calf.[9] Sexually mature females give birth once every 4 to 20 years (pregnancy rates were higher during the whaling era).[177] Birth is a social event, as the mother and calf need others to protect them from predators. The other adults may jostle and bite the newborn in its first hours.[179]

Lactation proceeds for 19 to 42 months, but calves, rarely, may suckle up to 13 years.[9] Like that of other whales, the sperm whale's milk has a higher fat content than that of terrestrial mammals: about 36%,[180] compared to 4% in cow milk. This gives it a consistency similar to cottage cheese,[181] which prevents it from dissolving in the water before the calf can eat it.[182] It has an energy content of roughly 3,840 kcal/kg,[180] compared to just 640 kcal/kg in cow milk.[183] Calves may be allowed to suckle from females other than their mothers.[9]

Males become sexually mature at 18 years. Upon reaching sexual maturity, males move to higher latitudes, where the water is colder and feeding is more productive. Females remain at lower latitudes.[9] Males reach their full size at about age 50.[40]

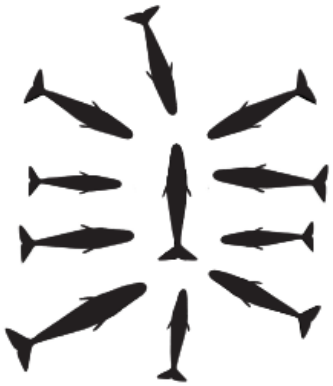
Social behaviour

Relations within the species

Like elephants, females and their young live in matriarchal groups called pods, while bulls live apart. Bulls sometimes form loose bachelor groups with other males of similar age and size. As they grow older, they typically live solitary lives, only returning to the pod to socialize or to breed .[40] Bulls have beached themselves together, suggesting a degree of cooperation which is not yet fully understood.[40] The whales rarely, if ever, leave their group.[184]

A *social unit* is a group of sperm whales who live and travel together over a period of years. Individuals rarely, if ever, join or leave a social unit. There is a huge variance in the size of social units. They are most commonly between six and nine individuals in size but can have more than twenty.[185] Unlike killer whales, sperm whales within a social unit show no significant tendency to associate with their genetic relatives.[186] Females and calves spend about three-quarters of their time foraging and a quarter of their time socializing. Socializing usually takes place in the afternoon.[187]

When sperm whales socialize, they emit complex patterns of clicks called codas. They will spend much of the time rubbing against each other. Tracking of diving whales suggests that groups engage in herding of prey, similar to bait balls created by other species, though the research needs to be confirmed by tracking the prey.[188][189]



Sperm whales adopt the "marguerite formation" to defend a vulnerable pod member.

Relations with other species

The most common natural predator of sperm whales is the killer whale, but pilot whales and false killer whales sometimes harass them.[190][191] Killer whales prey on target groups of females with young, usually making an effort to extract and kill a calf. The females will protect their calves or an injured adult by encircling them. They may face inwards with their tails out (the 'marguerite formation', named after the flower). The heavy and powerful tail of an adult whale is potentially capable of delivering lethal blows.[192] Alternatively, they may face outwards (the 'heads-out formation'). Other than sperm whales, southern right whales had been observed to perform similar formations.[193] However, formations in non-dangerous situations have been recorded as well.[193] Early whalers exploited this behaviour, attracting a whole unit by injuring one of its members.[194] Such a tactic is described in *Moby-Dick*:

> "Say you strike a Forty-barrel-bull—poor devil! all his comrades quit him. But strike a member of the harem school, and her companions swim around her with every token of concern, sometimes lingering so near her and so long, as themselves to fall a prey."[195]

If the killer whale pod is large, its members may sometimes be able to kill adult female sperm whales and can at least injure an entire pod of sperm whales.[196][197] Bulls have no predators, and are believed to be too large, powerful and aggressive to be threatened by killer whales.[198] Solitary bulls are known to interfere and come to the aid of vulnerable groups nearby.[199] However, the bull sperm whale, when accompanying pods of female sperm whales and their calves as such, may be reportedly unable to effectively dissuade killer whales from their attacks on the group, although the killer whales may end the attack sooner when a bull is present.[200][201] However, male sperm whales have been observed to attack and intimidate killer whale pods in competitive feeding instances. An incident was filmed from a long-line trawler: a killer whale pod was systematically taking fish caught on the trawler's long lines (as the lines were being pulled into the ship) when a male sperm whale appeared to repeatedly charge the killer whale pod in an attempt to drive them away; it was speculated by the film crew that the sperm whale was attempting to access the same fish. The killer whales employed a tail outward and tail-slapping defensive position against the bull sperm whale similar to that used by female sperm whales against attacking killer whales.[202] However, at some potential feeding sites, the killer whales may prevail over sperm whales even when outnumbered by the sperm whales. Some authors consider the killer whales "usually" behaviorally dominant over sperm whales but express that the two species are "fairly evenly matched", with the killer whales' greater aggression, more considerable biting force for their size and predatory prowess more than compensating for their smaller size.[200][203]

Sperm whales are not known for forging bonds with other species, but it was observed that a bottlenose dolphin with a spinal deformity had been accepted into a pod of sperm whales.[204] They are known to swim alongside other cetaceans such as humpback,[205] fin, minke, pilot,[206] and killer whales on occasion.[207]

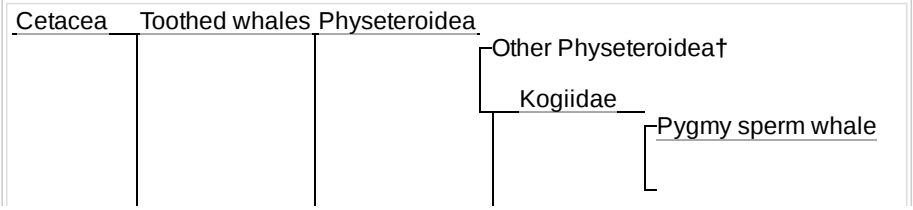
Parasites

Sperm whales can suffer of parasites. Out of 35 sperm whales caught during the 1976-1977 Antarctic whaling season, all of them were infected by *Anisakis physeteris* (in their stomachs) and *Phyllobothrium delphini* (in their blubber). Both whales with a placenta were infected with *Placentonema gigantissima*,[208] potentially the largest nematode worm ever described.

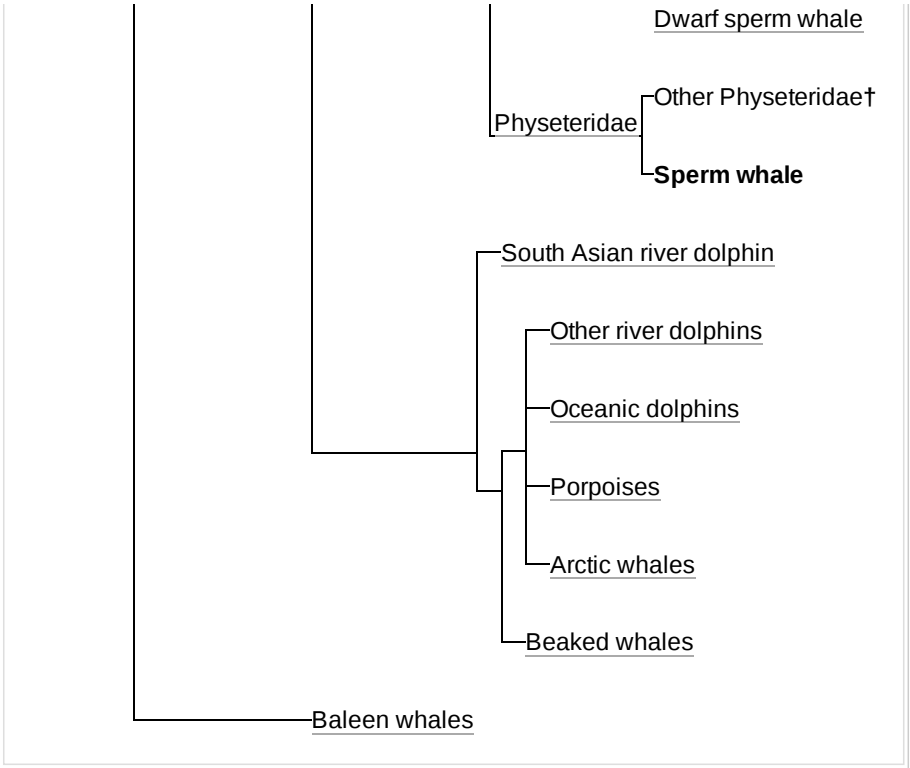
Evolutionary history

Fossil record

Although the fossil record is poor,[211] several extinct genera have been assigned to the clade Physeteroidea, which includes the last common



ancestor of the modern sperm whale, pygmy sperm whales, dwarf sperm whales, and extinct physeteroids. These fossils include *Ferecetotherium*, *Idiorophus*, *Diaphorocetus*, *Aulophyseter*, *Orycterocetus*, *Scaldicetus*, *Placoziphius*, *Zygophyseter* and *Acrophyseter*.[26][210][212] *Ferecetotherium*, found in Azerbaijan and dated to the late Oligocene (about 28 to 23 million years ago), is the most primitive fossil that has been found, which possesses sperm whale-specific features, such as an asymmetric rostrum ("beak" or "snout").[213] Most sperm whale fossils date from the Miocene period, 23 to 5 million years ago. *Diaphorocetus*, from Argentina, has been dated to the early Miocene. Fossil sperm whales from the Middle Miocene include *Aulophyseter*, *Idiorophus* and *Orycterocetus*, all of which were found on the West Coast of the United States, and *Scaldicetus*, found in Europe and Japan.[213][214] *Orycterocetus* fossils have also been found in the North Atlantic Ocean and the Mediterranean Sea, in addition to the west coast of the United States.[215] *Placoziphius*, found in Europe, and *Acrophyseter*, from Peru, are dated to the late Miocene.[26][213]



Evolutionary family tree of sperm whales,[209]
including simplified summary of extinct groups (†)[210]

Fossil sperm whales differ from modern sperm whales in tooth count and the shape of the face and jaws.[213] For example, *Scaldicetus* had a tapered rostrum.[214] Genera from the Oligocene and early and middle Miocene, with the possible exception of *Aulophyseter*, had teeth in their upper jaws.[213] *Acrophyseter*, from the late Miocene, also had teeth in both the upper and lower jaws as well as a short rostrum and an upward curving mandible (lower jaw).[26] These anatomical differences suggest that fossil species may not have necessarily been deep-sea squid eaters such as the modern sperm whale, but that some genera mainly ate fish.[213] *Zygophyseter*, dated from the middle to late Miocene and found in southern Italy, had teeth in both jaws and appears to have been adapted to feed on large prey, rather like the modern killer whale (orca). Other fossil sperm whales with adaptations similar to this are collectively known as killer sperm whales.[210]

Two fossil species belonging to the modern genus *Physeter* have been recognized so far: *P. antiquus* (Neogene of France)[216] and *P. vetus* (Neogene of eastern North America).[217]

Phylogeny

The traditional view has been that Mysticeti (baleen whales) and Odontoceti (toothed whales) arose from more primitive whales early in the Oligocene period, and that the super-family Physeteroidea, which contains the sperm whale, dwarf sperm whale, and pygmy sperm whale, diverged from other toothed whales soon after that, over 23 million years ago.[211][213] From 1993 to 1996, molecular phylogenetics analyses by Milinkovitch and colleagues, based on comparing the genes of various modern whales, suggested that the sperm whales are more closely related to the baleen whales than they are to other toothed whales, which would have meant that Odontoceti were not monophyletic; in other words, it did not consist of a single ancestral toothed whale species and all its descendants.[209] However, more recent studies, based on various combinations of comparative anatomy and molecular phylogenetics, criticised Milinkovitch's analysis on technical grounds and reaffirmed that the Odontoceti are monophyletic.[209][218][219]

These analyses also confirm that there was a rapid evolutionary radiation (diversification) of the Physeteroidea in the Miocene period.[210] The Kogiidae (dwarf and pygmy sperm whales) diverged from the Physeteridae (true sperm whales) at least 8 million years ago.[218]

Relationship with humans

Sperm whaling

Spermaceti, obtained primarily from the spermaceti organ, and sperm oil, obtained primarily from the blubber in the body, were much sought after by 18th, 19th, and 20th century whalers. These substances found a variety of commercial applications, such as candles, soap, cosmetics, machine oil, other specialised lubricants, lamp oil, pencils, crayons, leather waterproofing, rust-proofing materials and many pharmaceutical compounds.[220][221][222][223] Ambergris, a solid, waxy, flammable substance produced in the digestive system of sperm whales, was also sought as a fixative in perfumery.

Prior to the early eighteenth century, hunting was mostly by indigenous Indonesians.[224] Legend has it that sometime in the early 18th century, around 1712, Captain Christopher Hussey, while cruising for right whales near shore, was blown offshore by a northerly wind, where he encountered a sperm whale pod and killed one.[225] Although the story may not be true, sperm whales were indeed soon exploited by American whalers. Judge Paul Dudley, in his *Essay upon the Natural History of Whales* (1725), states that a certain Atkins, 10 or 12 years in the trade, was among the first to catch sperm whales sometime around 1720 off the New England coast.[226]

In the 19th century, sperm whales were hunted using rowboats and hand-thrown harpoons, a rather dangerous method, as the whales sometimes fought back.

There were only a few recorded instances during the first few decades (1709–1730s) of offshore sperm whaling. Instead, sloops concentrated on the Nantucket Shoals, where they would have taken right whales or went to the Davis Strait region to catch bowhead whales. By the early 1740s, with the advent of spermaceti candles (before 1743), American vessels began to focus on sperm whales. The diary of Benjamin Bangs (1721–1769) shows that, along with the bumpkin sloop he sailed, he found three other sloops flensing sperm whales off the coast of North Carolina in late May 1743.[227] On returning to Nantucket in the summer 1744 on a subsequent voyage, he noted that "45 spermacetes are brought in here this day," another indication that American sperm whaling was in full swing.[227]

American sperm whaling soon spread from the east coast of the American colonies to the Gulf Stream, the Grand Banks, West Africa (1763), the Azores (1765), and the South Atlantic (1770s). From 1770 to 1775 Massachusetts, New York, Connecticut, and Rhode Island ports produced 45,000 barrels of sperm oil annually, compared to 8,500 of whale oil.[228] In the same decade, the British began sperm whaling, employing American ships and personnel.[229] By the following decade, the French had entered the trade, also employing American expertise.[229] Sperm whaling increased until the mid-nineteenth century. Spermaceti oil was important in public lighting (for example, in lighthouses, where it was used in the United States until 1862, when it was replaced by lard oil, in turn replaced by petroleum) and for lubricating the machines (such as those used in cotton mills) of the Industrial Revolution. Sperm whaling declined in the second half of the nineteenth century, as petroleum came into broader use. In that sense, petroleum use may be said to have protected whale populations from even greater exploitation.[230][231] Sperm whaling in the 18th century began with small sloops carrying only one or two whaleboats. The fleet's scope and size increased over time, and larger ships entered the fishery. In the late 18th century and early 19th century, sperm whaling ships sailed to the equatorial Pacific, the Indian Ocean, Japan, the coast of Arabia, Australia and New Zealand.[229][232][233] Hunting could be dangerous to the crew, since sperm whales (especially bulls) will readily fight to defend themselves against attack, unlike most baleen whales. When dealing with a threat, sperm whales will use their huge head effectively as a battering ram.[106] Arguably the most famous sperm whale counter-attack occurred on 20 November 1820, when a whale claimed to be about 25.9 metres (85 ft) long rammed and sank the Nantucket whaleship *Essex*. Only 8 out of 21 sailors survived to be rescued by other ships.[234]

The sperm whale's ivory-like teeth were often sought by 18th- and 19th-century whalers, who used them to produce inked carvings known as *scrimshaw*. 30 teeth of the sperm whale can be used for ivory. Each of these teeth, up to 20 cm (8 in) and 8 cm (3 in) across, are hollow for the first half of their length. Like walrus ivory, sperm whale ivory has two distinct layers. However, sperm whale ivory contains a much thicker inner layer. Though a widely practised art in the 19th century, scrimshaw using genuine sperm whale ivory declined substantially after the retirement of the whaling fleets in the 1880s. Currently the Endangered Species Act and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), prevents the sales of or trade in sperm whale ivory harvested after 1973 or scrimshaw crafted from it.

Scrimshaw was the art of engraving on the teeth of sperm whales. It was a way for whalers to pass the time between hunts.

Modern whaling was more efficient than open-boat whaling, employing steam-powered ships and exploding harpoons. Initially, modern whaling activity focused on large baleen whales, but as these populations were taken, sperm whaling increased. Spermaceti, the fine waxy oil produced by sperm whales, was in high demand. In both the 1941–1942 and 1942–1943 seasons, Norwegian expeditions took over 3,000 sperm whales off the coast of Peru alone. After World War II, whaling continued unabated to obtain oil for cosmetics and high-performance machinery, such as automobile transmissions.

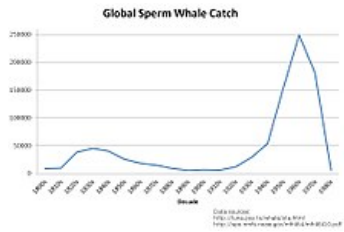
The hunting led to the near-extinction of large whales, including sperm whales, until bans on whale oil use were instituted in 1972. The International Whaling Commission gave the species full protection in 1985, but hunting by Japan in the northern Pacific Ocean continued until 1988.[231]

It is estimated that the historic worldwide population numbered 1,100,000 before commercial sperm whaling began in the early 18th century.[3] By 1880, it had declined by an estimated 29 percent.[3] From that date until 1946, the population appears to have partially recovered as whaling activity decreased, but after the Second World War, the population declined even further, to 33 per cent of the pre-whaling population. Between 184,000 and 236,000 sperm whales were killed by the various whaling nations in the 19th century,[235] while in the 20th century, at least 770,000 were taken, the majority between 1946 and 1980.[236]

Sperm whales increase levels of primary production and carbon export by depositing iron-rich faeces into surface waters of the Southern Ocean. The iron-rich faeces cause phytoplankton to grow and take up more carbon from the atmosphere. When the phytoplankton dies, it sinks to the deep ocean and takes the atmospheric carbon with it. By reducing the abundance of sperm whales in the Southern Ocean, whaling has resulted in an extra 2 million tonnes of carbon remaining in the atmosphere each year.[237]

Remaining sperm whale populations are large enough that the species' conservation status is rated as vulnerable rather than endangered.[3] However, the recovery from centuries of commercial whaling is a slow process, particularly in the South Pacific, where the toll on breeding-age males was severe.[238]

Current conservation status



Sperm whaling peaked in the 1830s and 1960s.

The total number of sperm whales in the world is unknown, but is thought to be in the hundreds of thousands.[3] The conservation outlook is brighter than for many other whales. Commercial whaling has ceased,[3] and the species is protected almost worldwide, though records indicate that in the 11-year period starting from 2000, Japan has caught 51 sperm whales. Fishermen do not target the creatures sperm whales eat,[3] but long-line fishing operations in the Gulf of Alaska have complained about sperm whales stealing fish from their lines.[161]

Currently, entanglement in fishing nets and collisions with ships represent the greatest threats to the sperm whale population.[10] Other threats include ingestion of marine debris, ocean noise, and chemical pollution.[239] The International Union for Conservation of Nature (IUCN) regards the sperm whale as being "vulnerable".[3] The species is listed as endangered on the United States Endangered Species Act.[240]

Sperm whales are listed on Appendix I[241] and Appendix II[241] of the Convention on the Conservation of Migratory Species of Wild Animals (CMS). It is listed on Appendix I[241] as this species has been categorized as being in danger of extinction throughout all or a significant proportion of their range and CMS Parties strive towards strictly protecting these animals, conserving or restoring the places where they live, mitigating obstacles to migration and controlling other factors that might endanger them. It is listed on Appendix II[241] as it has an unfavourable conservation status or would benefit significantly from international co-operation organised by tailored agreements. It is also covered by the Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS) and the Memorandum of Understanding for the Conservation of Cetaceans and Their Habitats in the Pacific Islands Region (Pacific Cetaceans MOU).

Cultural importance


Sperm whale teeth necklace from Fiji

Rope-mounted teeth are important cultural objects throughout the Pacific. In New Zealand, the Māori know them as "rei puta"; such whale tooth pendants were rare objects because sperm whales were not actively hunted in traditional Māori society.[242] Whale ivory and bone were taken from beached whales. In Fiji the teeth are known as *tabua*, traditionally given as gifts for atonement or esteem (called *sevusevu*), and were important in negotiations between rival chiefs.[243] Friedrich Ratzel in *The History of Mankind* reported in 1896 that, in Fiji, whales' or cachalots' teeth were the most-demanded article of ornament or value. They occurred often in necklaces.[244] Today the tabua remains an important item in Fijian life. The teeth were originally rare in Fiji and Tonga, which exported teeth, but with the Europeans' arrival, teeth flooded the market and this "currency" collapsed. The oversupply led in turn to the development of the European art of scrimshaw.[245]

Herman Melville's novel *Moby-Dick* is based on a true story about a sperm whale that attacked and sank the whaleship *Essex*.[246][247] Melville associated the sperm whale with the Bible's Leviathan.[247][248] The fearsome reputation perpetuated by Melville was based on bull whales' ability to fiercely defend themselves from attacks by early whalers, smashing whaling boats and, occasionally, attacking and destroying whaling ships.

In Jules Verne's *Twenty Thousand Leagues Under the Sea*, the Nautilus fights a group of "cachalots" (sperm whales) to protect a pod of southern right whales from their attacks. Verne portrays them as being savage hunters ("nothing but mouth and teeth").

The sperm whale was designated as the Connecticut state animal by the General Assembly in 1975.[249] It was selected because of its specific contribution to the state's history and because of its present-day plight as an endangered species.[250]

Watching sperm whales

Sperm whales are not the easiest of whales to watch, due to their long dive times and ability to travel long distances underwater. However, due to the distinctive look and large size of the whale, watching is increasingly popular. Sperm whale watchers often use hydrophones to listen to the clicks of the whales and locate them before they surface. Popular locations for sperm whale watching include the town of Kaikoura on New Zealand's South Island, Andenes and Tromsø in Arctic Norway; as well as the Azores, where the continental shelf is so narrow that whales can be observed from the shore,[141][251] and Dominica[252] where a long-term scientific research program, The Dominica Sperm Whale Project, has been in operation since 2005.[253]

Plastic waste

The introduction of plastic waste to the ocean environment by humans is relatively new. From the 1970s, sperm whales have occasionally been found with pieces of plastic in their stomachs.[167][254][255][256]

See also

- List of sperm whale strandings
- List of cetaceans
- Marine biology

Notes

a. /ˈkæʃəlɒt, ˈkæʃəloʊ/ – "cachalot" (https://oed.com/search?searchType=dictionary&q=cachalot). *Oxford English Dictionary* (Online ed.). Oxford University Press. (Subscription or participating institution membership (https://www.oed.com/public/login/loggingin#withyourlibrary) required.)

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External links

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