## 4
## BEHAVIOR



## 5
## ECOLOGY AND CONSERVATION

# Oyster Bear

## A bizarre fossil marine mammal from the Pacific Northwest is dubbed the "oyster bear" and likely crushed hard-shelled invertebrates with its broad teeth.

**SIZE**

Males & females
Length: 4 ft (1.2 m)
Weight: 180 lb (82 kg)

**DIET**

Mollusks

**HABITAT**

Coastal marine

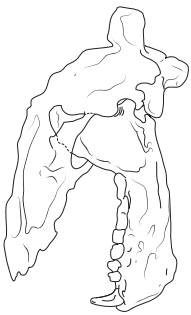
**AGE**

20 mya

The oyster bear (*Kolponomos newportensis*) was originally described in the 1960s from the Olympic Peninsula of Washington by the University of California Museum of Paleontology's Ruben A. Stirton, who initially interpreted this animal as a marine racoon. Later discoveries of complete skulls and jaws and a second species, *Kolponomos clallamensis*, from the early Miocene of Oregon (Nye Mudstone) and Washington (Clallam Formation) was described. Another specimen, an upper jaw fragment from the early Miocene of Unalaska Island, Alaska was referred to cf. *Kolponomos*.

The oyster bear had a massive skull with a markedly downturned snout. The eyes were directed anteriorly rather than to the sides of the head, suggesting the oyster bear could see objects directly in front of its head, which would have aided an animal selectively eating rock dwelling benthic or attached invertebrates. The enlarged muzzle, lips, and whisker development suggest that this species had enhanced tactile sensitivity. Large paroccipital and mastoid processes on the back of the skull indicate that the oyster bear had well-developed neck muscles that could have enabled strong downward movements of the head.

One of the most distinguishing features of the oyster bear is the way that it fed. Rather than having teeth that could cut meat like other carnivorans, such as cats, bears, and dogs, it crushed mollusks in its robust jaws studded with broad teeth with rounded cusps. Using multiple lines of evidence, including analysis of bite forces of the lower jaws as well as observations of tooth wear by paleontologists, showed that the oyster bear and the saber-toothed cat (*Smilodon*) independently evolved a similar jaw shape and function. The front of the jaw in the oyster bear is deep and buttressed, giving it a prominent chin like the saber-toothed cat and it may have used a similar strategy of anchoring the head with the lower jaw and then using the leverage to produce a powerful bite similar to the saber-toothed cat but without elongated canine teeth. As described by Riley Black, *Kolponomos* "bit like a saber-toothed cat, crunched like a bear." A unique prey capture-mastication sequence was proposed for the oyster bear that does not have a close analogue in species in modern ecosystems. Initially prey capture involved anchoring and wedging of the



The extinct oyster bear had a massive skull with crushing teeth, strong limb musculature, and robust fingers and toes, suggesting that this animal was adapted for life on land and in the water.

lower incisors and canines between the shelled prey and the substrate, followed by closure of the mouth so that the upper and lower anterior teeth bracketed the shell of the prey. Next, high torque was applied as a fulcrum to dislodge the prey from the substrate, assisted by powerful neck muscles. Finally, in crushing bites, the hard-shelled prey were smashed using their otter-like teeth.

The few known limb and foot elements indicate that the oyster bear was not fully aquatic. Likely it was semiaquatic and capable of movement on land and in the water. The forearm musculature was strong and the robust digits were capable of powerful movement and may have been used to procure food.

The evolutionary relationship of the oyster bear to other carnivores has been debated, allying this animal with pinnipeds or at the base of arctoid carnivorans (bears, racoons, weasels, and related forms). The current best-supported hypothesis places this species as intermediate between bears and bear-dogs, in the Amphicynodontidae, which includes *Amphicynodon, Pachycynodon, Allocyon,* and *Kolponomos*. *Kolponomos* and *Allocyon* are hypothesized to be the group from which Pinnipedimorpha (seals, sea lions, walruses, and their kin) arose.

# GIANT OTTER

## The giant otter may have evolved in fresh water and followed river systems like modern river otters to disperse to nearshore environments.

Large otters of the genus *Enhydritherium* (from the Greek *enhydris*, "otter" and "beast") are known by two species. *Enhydritherium lluecai* is known from the late Miocene of Europe (Spain). A second species, the giant otter *Enhydritherium terranovae* (from the Latin *terra* meaning "earth" or "land" and *novus* meaning "new"), originally described based mostly on teeth and lower jaw fragments, is now known by additional material including a partial skeleton. The giant otter had a wide geographic range and is reported from marginal marine deposits and freshwater deposits in Florida and California as well as from freshwater deposits in Mexico from the late Miocene to early Pliocene. These discoveries suggest that the giant otter is likely to have spent more time on land than the living sea otter (*Enhydra lutris*) following river systems and traveling overland for considerable distances between water, much like modern river otters *(Lontra canadensis*).

The skull of the giant otter resembles that of a typical river otter, with a distinctly rounded cranium and relatively broad frontal structure. Features of the nuchal crest and the robust, elongated mastoid, suggest that this species possessed neck muscles more powerful than living otters. The lower jaw is similar to that of *Lutra* and not as massive as in the sea otter *Enhydra*. The thickened tooth cusps of the giant otter and their tendency to show heavy wear suggests that these otters, like the modern sea otter, consumed extremely hard food items such as mollusks in addition to fish.

Although the modern sea otter displays specializations for hind limb propulsion such as elongated distal hind limb elements, the giant otter with its heavily developed upper arm muscle insertion surfaces suggest that unlike *Enhydra* this extinct otter was a forelimb swimmer. The foot bones of *Enhydritherium* are similar to another fossil otter *Enhydriodon* and differ from those of other otters in being short and slender, little longer than the hand bones. In *Enhydra* the foot bones are elongated and flattened as a swimming adaptation. The distal phalanges differ from those of other otters in having extremely large ungual sheaths, suggesting the presence of exceptionally large claws. It is unclear whether *Enhydritherium* like *Enhydra* possessed retractile claws. With more balanced forelimb/hind limb proportions *Enhydritherium* was likely more efficient at locomotion on land.

**SIZE**

Males & females
Length: 3 ft–4 ft (1.2 m–1.5 m)
Weight: 50 lb–100 lb (22 kg–45 kg)

**DIET**

Fish and shellfish

**HABITAT**

Nearshore marine; estuarine and inland fresh water

**AGE**

6.5–4.5 mya

The extinct giant otter swam by using its forelimbs rather than by the hind limb propulsion that is seen in modern otters.

The giant otter is thought to be related to both the Old World otter *Enhydriodon* and the modern New World sea otter *Enhydra*—all are assigned to the river otter subfamily Lutrinae in the family Mustelidae, including skunks, ferrets, martens, and minks.

# Echo-hunting Whale

## Discovery of the echo-hunting whale, found in 25-million-year-old deposits in South Carolina, US, suggests that echolocation evolved early in whales.

*Echovenator sandersi* is the earliest whale to have evolved echolocation, the ability to produce high-frequency sounds that bounced off prey, creating echoes received by the inner ear. The name *Echovenator* comes from the Latin for "echo hunter" referring to echolocation. This small toothed whale is a member of the family Xenorophidae, the most basal group of toothed whales and a distant relative of modern dolphins. *Echovenator* is represented by a nearly complete skull that was found in nearshore marine deposits of the Oligocene Chandler Bridge Formation in South Carolina. Paleontologists analyzed high-resolution CT scans of *Echovenator*'s well-preserved ear and uncovered many features, such as a loosely coiled cochlea, a spiral cavity of the inner ear that contains hearing receptors; this is found also in today's dolphins that can hear high-frequency sounds. Other features of the skull of *Echovenator*, such as bony correlates for facial air sacs and expanded attachment areas for facial musculature, support its capability for echolocation although in a less specialized form than modern toothed whales. Study of the facial region of the skull in another early toothed whale fossil *Cotylocara macei* demonstrate that xenorophids already had the ability to produce echolocation sounds. These early toothed whale fossils confirm that the Oligocene (30–25 mya) represents an important period of whale evolution with fossils documenting the initial diversification of both toothed and baleen whales from stem whales, ancestral Eocene archaeocetes.

Echolocation was a key innovation, which is one of the major reasons why toothed whales were so successful, so its early evolution is significant. As determined from studying the ears of *Echovenator*, it appears that the ability to hear high-frequency sounds evolved before the ability to produce high-frequency sounds, and echolocation became even more specialized in toothed whales. Baleen whales that do not echolocate and are specialized to produce and hear low-frequency (infrasonic) sounds used in long distance communication lost some of their initial specializations for hearing high-frequency sounds. These results are contrary to the traditional hypothesis that toothed whales evolved from low-frequency hearing specialists. Whales started becoming sensitive to high-frequency sounds before the two major groups alive today—the toothed whales and baleen whales—split from each other.

**SIZE**

Males & females
Length: 4 ft 10 in (1.48 m)
Weight: Unknown

**DIET**

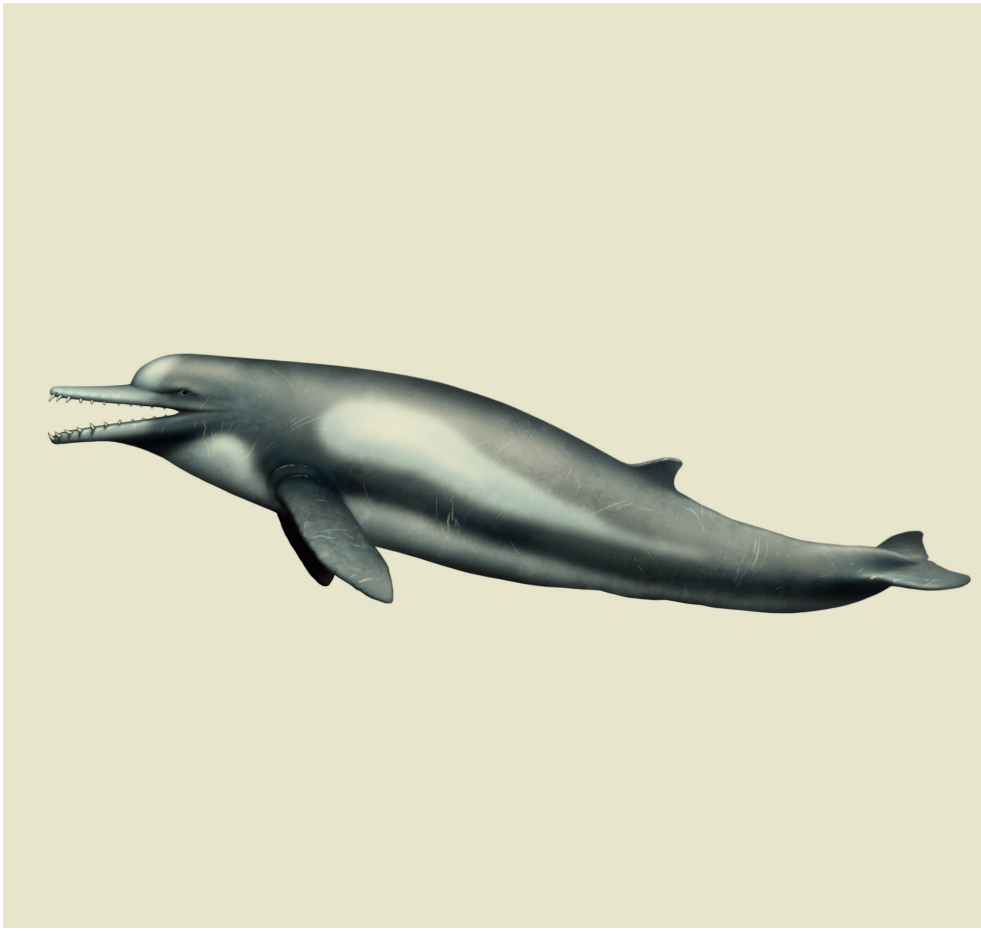
Fish

**HABITAT**

Coastal marine

**AGE**

c. 27–24 mya



The extinct echo-hunting whale had well-developed hearing receptors in its inner ear. It is believed to be the earliest whale to have evolved echolocation.

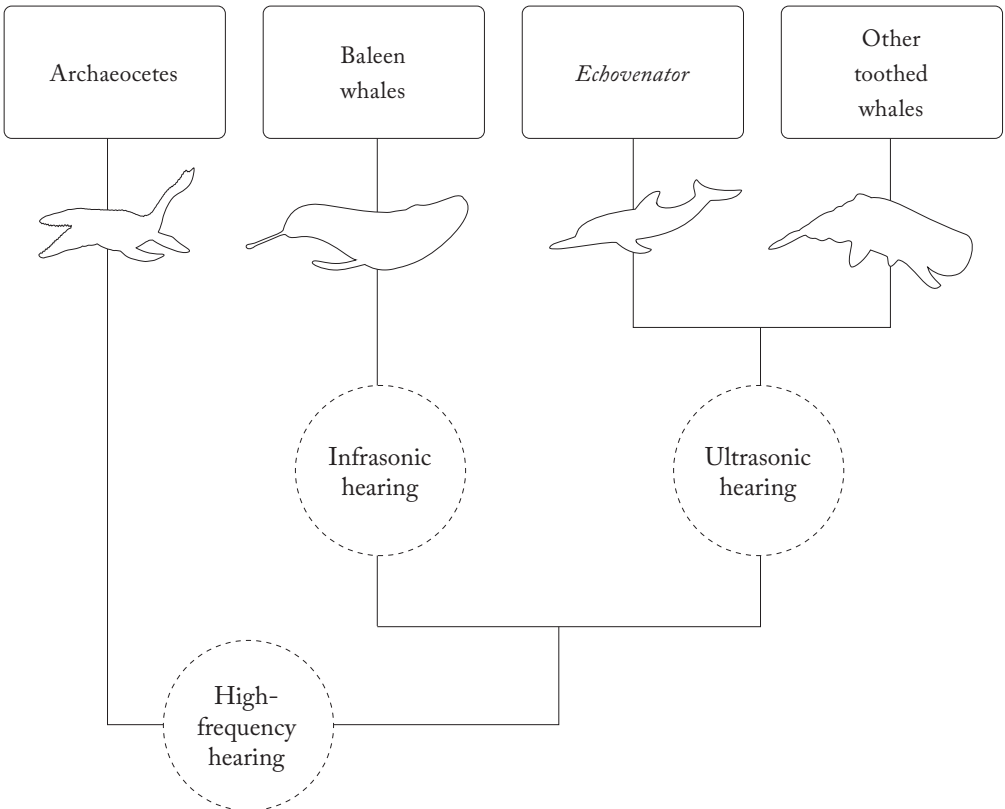
The evolution of toothed whales is closely tied to the origin of echolocation. Scientists have suggested that echolocation in early toothed whales was initially an adaptation for feeding at night on vertically migrating mollusks, especially nautiloids (shelled cephalopods, relatives of squid and octopuses). Echolocation appears to have coevolved in predator (toothed whales) and prey (nautiloids). Evidence for this is the production of stronger echoes by gas-filled nautiloids compared to soft-bodied cephalopods, such as squid. These nautiloids would have been easily detectable prey for early echolocating toothed whales and may be responsible for their near demise 25 mya. Subsequent modification of echolocation with finer resolution, as documented in the fossil record, was driven by whales hunting squid and other prey in deep water.

## Echolocation: Seeing in the Dark with Sound

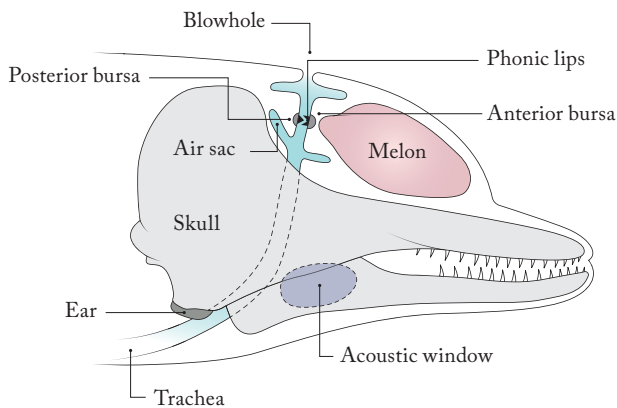
Unlike baleen whales, toothed whales locate and hunt in dark and murky environments, at night or at great depth, using echolocation. The ability to navigate using high-frequency sounds well above the range of human hearing, and reception of its echo, is called echolocation. Toothed whales are rivaled only by some bats in their capacity to produce and hear ultrasonic sound, typically between 120–180 kHz. For comparison, humans hear in the range of .02–17 kHz. Unlike humans, where sounds are produced in the larynx or voicebox, the echolocation sounds of toothed whales are produced in the nasal region. The sounds are emitted through the "phonic lips"—paired, fat-filled structures, suspended within muscles and air spaces near the blowhole. The phonic lips are embedded in a pair of anterior and posterior bursae that help direct the sound beam. The melon acts as a lens to focus sounds. The returning echoes pass through and under the lower jaw fat bodies before being transmitted to the middle and inner ear. This remarkable adaptation is so precise that toothed whales can distinguish very small differences in the size and type of prey they are targeting, and can also penetrate into sand or mud to locate buried prey.

Toothed whales feed mostly on fish and squid; however, some, such as killer and false killer whales, hunt and eat larger prey such as other marine mammals (see page 92).

The independent evolution of echolocation in whales and bats are excellent examples of convergent evolution where organisms that are not closely related resemble one another. This adaptation allowed both groups to take advantage of unexploited food resources. Although different in details, the echolocation abilities of bats and toothed whales rely on the same changes at the molecular level—the presence of the gene prestin—a remarkable example of independent acquisition in two diverse groups. The discovery of prestin in echolocating species and its function as an amplifier for high-frequency sounds is significant, since there is concern about how noise pollution affects hearing in whales. Exposure to high-intensity sound for long periods of time can damage hearing neurons, affecting echolocation, which toothed whales rely on for orientation and feeding. Ultimately, this may lead to hearing loss, which has been found to result in stranding and death in some whales.




Generalized hearing apparatus illustrating sound production, which occurs through the phonic lips, air sacs, and bursae. Sound reception is through the acoustic window, a fat channel of sound-conducting tissue in the lower jaw.



# 2
# DISCOVERY

Whether reporting a new animal previously unknown to science, or collecting fossils using nontraditional means, significant discoveries of extinct and living sea mammals have been and continue to be made around the world.

Among the species selected for this chapter is an early whale from the southeastern US whose large bones were originally thought to be from a dinosaur. In a highly unusual method of discovery, fossil dolphins and beaked whales not previously known were dredged from the seafloor by fishing vessels in the North Sea and the Atlantic. Another remarkable discovery is a fossil whale skull embedded in limestone from Egypt that was being cut into decorative slabs at a commercial quarry. Also reported is a fossil whale graveyard in Chile discovered during the expansion of the Pan-American Highway. With no time to remove specimens, it was critically important to record a snapshot of the discovery site using laser imagery that enabled later study of specimens. Amazingly, the largest animals on Earth continue to be regularly discovered, including several new species of both toothed and baleen whales from the Gulf of Mexico and the North Pacific.

A novel yet controversial hypothesis proposed that the mystery of the origin of the modern pygmy right whale was solved and that it was a member of a fossil group long thought to be extinct.

PAGE 48
An African manatee cub and its mother (foreground) (*Trichechus sengalensis*), seen at Chimelong Ocean Kingdom in Zhuhai, China. Like all marine mammals that live in the water, the manatee must surface to breathe.

Mermaids have long been associated with sea cows and this legend when traced back was found to be based on early reported observations of both manatees and dugongs. Sea unicorns, another legend, most likely refer to the narwhal's uniquely developed spiral tusk.

A new fossil walrus discovery is based on a nearly complete skeleton from southern California, adding to the past diversity of more than 20 walrus species in contrast to the present-day single Arctic species. The report of an extinct seal relative from California adds new information to our knowledge of the decline and extinction of a fossil lineage, suggesting that declining temperatures played a role as did competition with rapidly diversifying walruses. Discovery of the coexistence of several sea cow species at different times and places in various parts of the world suggest that they avoided competition by dividing up limited resources, analogous to ecological interactions among coexisting species in modern communities.

# "King of Lizards"

## Originally identified as a dinosaur and described as the "king of lizards," this species is not a reptile but a whale.

Since Aristotle's time (384–322 BCE) whales have been recognized as mammals and not fish because they have hair, lungs, lack gills, suckle their young by means of mammae, and give birth to live young. During the Renaissance, the Italian artist and engineer Leonardo da Vinci is credited with a description of the first whale fossil found in a cave in Tuscany, Italy, in the fifteenth century. But it was not until the eighteenth century that a fossil whale was first named, although at the time it was thought to be a gigantic lizard.

A skeleton of what was believed to be a large sea serpent was found in Alabama in 1842; it had a partial skull, forelimb, and vertebral column extending nearly 65 feet (20 m). This discovery prompted the German fossil collector Albert Koch to visit Alabama and purchase the bones from farmers. He strung the bones together and reconstructed a single specimen nearly 114 feet (35 m) long; it had a long body, giant flippers, and a huge mouth. He claimed that such a skeleton belonged to a "sea serpent" that he named *Hydrarchos sillimani* after Yale professor and friend of Koch, Benjamin Silliman. The "skeleton" was exhibited in New York and Europe and thousands flocked to see it; most thought that it proved the existence of sea serpents. Later, more careful examination showed that the skeleton in question was a composite of at least five different specimens. Other similar bones including a large vertebra or backbone from the Eocene of Louisiana were published in 1834 by Richard Harlan, American geologist and paleontologist. However, he also did not recognize his find to be from a whale. Rather, he identified it as a dinosaur and proposed to call the animal "the king of lizards" or *Basilosaurus*.

Among additional fossil remains of similar animals found on an Alabama plantation were teeth that were examined by the well-known English anatomist Richard Owen. In 1839, Owen proposed a new name for the teeth and bones, which he recognized as deriving not from a dinosaur or other reptiles but from an extinct whale which he named *Zeuglodon cetoides*, choosing the genus name in recognition of the yoke-like shape of its back teeth (*zeugleh* means "yoke" in Greek and the Latin *dens* means "teeth"), and the species name in recognition of the appearance of its whale-like vertebrae (*cetoides*). However, the first published name takes precedence, in this case, rendering these specimens *Basilosaurus cetoides*.

**SIZE**

Males & females
Length: 60 ft–70 ft (17 m–20 m)
Weight: Unknown

**DIET**

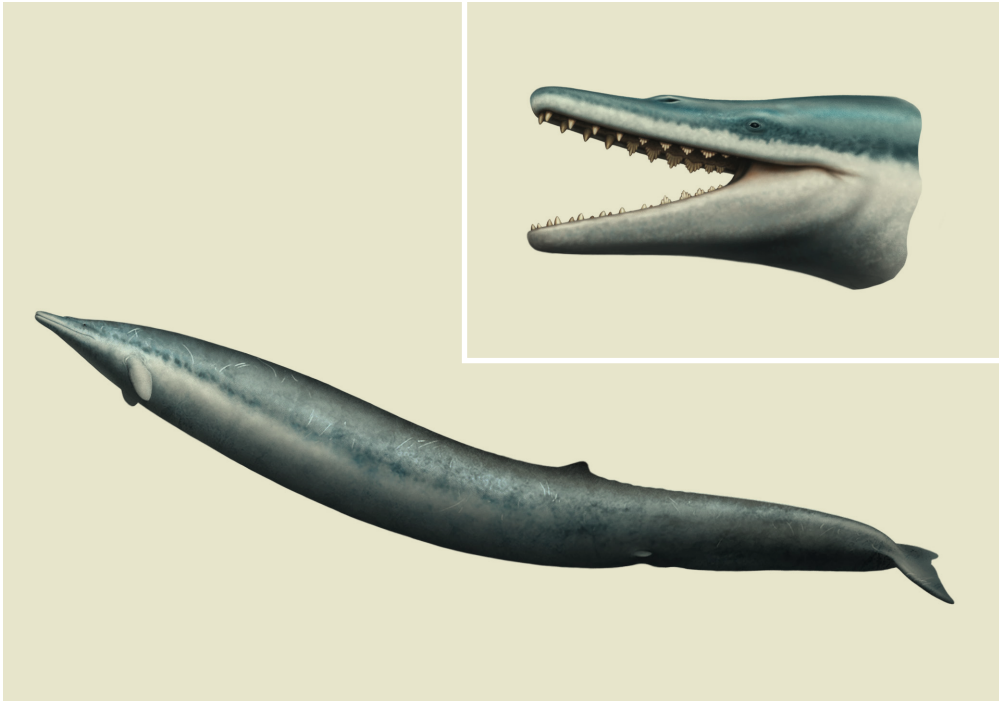
Large fish

**HABITAT**

Nearshore marine

**AGE**

35–34 mya



The extinct large stem whale (*Basilosaurus isis*) was the top marine predator of its day, more than 35 million years ago. It had large teeth and a powerful bite, and likely fed on the bones of other cetaceans.

Basilosaurids are recognized today as a family of stem whales comprised of approximately 13 genera and 19 species. They grew to 60–70 feet (18–20 m) and possessed greatly reduced hind limbs with well-formed legs and feet. They were one of the earliest fully aquatic cetaceans. Study of tooth wear in basilosaurids suggests they were large predators with a forceful, crushing bite feeding on the bones of other cetaceans. The genus *Basilosaurus* includes three species that lived from 45 to 35 mya; fossils were found in rocks along the shores of the Tethys Sea (North Atlantic coast of southeastern US), West Africa (Egypt), and possibly Pakistan. *Basilosaurus cetoides* is known from Georgia, Alabama, and Mississippi and it is recognized as the official state fossil of Alabama and Mississippi. The slightly smaller *Basilosaurus isis* is known from many skeletons in Egypt, the majority collected from Wadi Al-Hitan "Valley of Whales" in the Fayum desert, now an internationally known and much-visited UNESCO World Heritage Site (see page 16). Basilosaurids lived in warm, tropical seas of the Eocene, becoming extinct at the transition between the end of the Eocene and the beginning of the Oligocene, a time of climatic change when temperatures cooled.

# Pygmy Right Whale

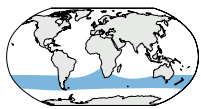
## The pygmy right whale is the most cryptic and least known in terms of morphology and behavior of the living baleen whales.

*Caperea marginata* is commonly called the pygmy right whale. The name *Caperea* means "wrinkle," referring to the wrinkled appearance of the ear bone, while *marginata* refers to the dark border around the baleen plates of some individuals. It is the sole member of the family Neobalaenidae. Its name pygmy right whale is a misnomer since it differs significantly from right whales (family Balaenidae). It is the smallest baleen whale and has a distinctive skull and skeleton that features large horizontal processes on the vertebrae, and overlapping ribs that restrict mobility in the chest region. It is also the only living whale lineage confined to the Southern Hemisphere, where it is rarely seen. We know more about the pygmy right whale from dead individuals than from live ones.

Pygmy right whales are slender, resembling the streamlined balaenopterids rather than the chunky right whales and bowhead. They have dark gray backs that shade to white on the belly and a pair of chevron-shaped lighter patches behind the eyes. Two grooves are located on the throat similar to the throat grooves of the gray whale. Although the rostrum is arched it is not as conspicuous as in balaenids. They have a small curved dorsal fin located near the posterior end of the body. Like other baleen whales, the ear of *Caperea* was specialized for hearing low-frequency sounds; however, its hearing limit is relatively high.

Although it is not known whether this species is migratory it has a circumpolar distribution in both coastal and oceanic waters within temperate regions. When seen they are usually located within sheltered bays. The whale is typically sighted alone or in pairs. They do not exhibit behaviors commonly seen in other whales such as spy hopping or breaching. Although there is little information on diet, pygmy right whales are skim feeders, and they are known to feed on copepods and krill.

The evolutionary relationships of the pygmy right whale have long been debated. *Caperea* has been allied either with rorquals and gray whales (families Balaenopteridae and Eschrichtiidae) using molecular data and right whales (Balaenidae) based on morphology. Molecular analysis, combined with studies of their bone structure (especially ears) from fossils and other remains, has revealed a third hypothesis, that it is the only survivor of a lineage (family Cetotheriidae) thought to have gone extinct 2 mya. Because of this, researchers refer to the



**SIZE**

Males & females
Length: 20 ft–21 ft (6 m–6.5 m)
Weight: 7.25 tons–8.5 tons (6.3 tonnes–7.26 tonnes)
Females longer than males at birth by 6 ft 6 in (2 m)

**DIET**

Copepods and euphausiids

**HABITAT**

Coastal and oceanic

**LIFE HISTORY**

Sexual maturity may occur at lengths greater than 16 ft 4 in (5 m)
Gestation: 10–12 months
Reproduce: 2 years

**STATUS**

Least concern

The pygmy right whale is the smallest and most elusive of the baleen whales. It has a narrow, downturned rostrum and a pale light-colored chevron near the level of the flippers.

pygmy right whale as a "living fossil," a living species that resembles an ancestral species known only from the fossil record. According to the cetotheriid hypothesis *Caperea* reportedly shares several ear characters with some cetotheres. However, disagreement about whether these shared features represent common ancestry, convergence (independent acquisition), or primitive similarities is at the crux of the matter and will require further analyses of characters and fossils.

Prior to 2012 fossils of the *Caperea* lineage were unknown. Since then, new specimens of this lineage have been found in the late Miocene (up to 10 mya) rocks of Australia, Argentina, and Peru. Recent description of two Pleistocene *Caperea*-like fossils in the Northern Hemisphere from Italy (1.8 mya) and Japan (less than 1 mya) provided the first evidence that *Caperea* crossed the Equator, probably during the brief interglacial intervals associated with pronounced cooling that accompanied Northern Hemisphere glaciation. With falling temperatures, waters near the Equator cooled and became richer in nutrients, which would have made it easier for *Caperea* to extend its range beyond the tropics into the Northern Hemisphere. Other marine mammals including some dolphins, right whales, and elephant seals have made similar journeys. However, as the glacial period was followed by an interglacial period, tropical seas warmed and productivity declined. What was once a tropical gateway became an impassable barrier, leaving populations trapped on either side of the Equator in a warming ocean. Some divided marine mammal populations evolved into separate species such as right whales and elephant seals, but others declined to extinction in one hemisphere, like *Caperea* in the north.

The pygmy right whale was never exploited during commercial whaling, probably because of its small size.

# Early Whale

## One of the most unusual fossil whale finds is a cross section of a skull discovered by a quarry worker in a limestone block.

In 2003 the owner of a marble-cutting company in Tuscany, Italy, had just acquired a block of Egyptian marbleized limestone. After slicing the block into slabs, he discovered the bones of an animal. Thinking that he had discovered a dinosaur, he contacted paleontologist Giovanni Bianucci at nearby University of Pisa. Bianucci recognized the bones as belonging to an early whale. However, before he could provide a more specific identification he needed to know more about where the limestone slabs had come from. The slabs were marketed as "Sheikh Fadl limestone." With knowledge that Sheikh Fadl was a city in Egypt, Bianucci discovered several limestone quarries in the Tarfa Valley east of the city. Bianucci and collaborator Philip Gingerich from the University of Michigan traveled to the limestone quarry and discovered that the rocks were 40 mya. Bianucci and Gingerich named the fossil whale that nearly wound up as a countertop *Aegyptocetus tarfa*—"Egyptian whale from Tarfa." Once the slabs containing bones were put back together, Bianucci and Gingerich were able to reconstruct the skull and the associated partial skeleton. The new fossil species was identified as a protocetid, a group of early whales. The first of this group to be found—*Protocetus atavus*—was also located at an Egyptian rock quarry by workmen who were extracting building stone.

Although the limbs are missing, further study of the exceptionally preserved skull of *Aegyptocetus* revealed that it had well-developed turbinal bones, providing evidence for a highly developed sense of smell, a feature not seen in modern whales. Both the skull and jaws show adaptations for hearing in water, such as a downward slope to the skull, thin-walled ear bones, and a large canal in the lower jaw that helps channel sound to the ears. Long neural spines on the anterior thoracic vertebrae indicate that *Aegyptocetus* was able to support its weight on land like other protocetids. The combination of terrestrial and aquatic characters

SIZE
Males & females
Length: Unknown
Weight: 1,433 lb
(650 kg)

DIET
Fish

HABITAT
Coastal

AGE
41–40 mya

An extinct protocetid whale had powerful jaws and teeth. The well-developed hind limbs and tail were used in locomotion, which suggested that it was active on both land and in the water.

indicate that *Aegyptocetus* was probably semiaquatic. The bones also suggest how it died. Four of the ribs contain tooth marks of a shark, which must have swum upward at the animal and bitten it on the left flank. Today's white shark uses the same strategy and other fossil whales bear the marks of similar attacks by predators.

# Narwhal

## Known as "sea unicorns," narwhals are toothed whales that have uniquely evolved a long spiral tusk protruding forward from their upper lip.

Sea unicorns with their prominent single horn are mythological animals, typically pure white horses that have a spiral tusk; they can be traced back to classical times. Unicorn horn was traded through the Middle Ages and Renaissance by Vikings. The unicorn horn had magical powers ascribed to it and it was believed to ward off disease, so parts of the tusk were worn as necklaces or ground up and prescribed as medicine. In one of the most ostentatious displays of power and wealth, the Danish Royal Throne chair made in the mid-seventeenth century and housed today in Copenhagen is constructed of numerous unicorn "horns."

The source of the horn is actually the elongated, up to 9 feet (2.7 m) long, spiral tusk (canine tooth) that protrudes from the left upper lip of a male narwhal, though some males develop two tusks. Females sometimes develop small tusks, too, but they usually remain embedded in the upper jaw. It is likely that the unicorn was based on findings of the tusk of the modern narwhal (*Monodon monoceros*), meaning one tooth, one horn, hence the name "the unicorns of the sea." Narwhals are restricted to the Arctic, occurring mostly above the Arctic Circle. They inhabit the Atlantic portion of the Arctic and have a few records of discovery in the Pacific portion.

Various functions have been proposed for the male narwhal tusk, ranging from its use in hunting, or as an environmental sensor or, as most recently proposed, a sexually selected trait developed in males to attract females, similar to a peacock's tail or deer antlers. It is also possible that the tusk has several functions. The environmental sensor hypothesis is based on study of the structure of the tusk, which contains nerve endings of the inner core that connect to the outer surface and makes the tusk sensitive to temperature and chemical changes in the water, using them to find food and helping them to locate females ready to mate. Another possibility is that sensing the environment might help the whales survive the harsh and ever-changing conditions in the Arctic. Video footage has also shown that the tusk is used in hunting prey; narwhals are seen striking Arctic cod with their tusks to stun them before eating.

**SIZE**

Males: length up to 16 ft (4.9 m); weight up to 1.7 tons (1.54 tonnes)
Females: length up to 14 ft (4.3 m); weight up to 1.1 tons (1 tonne)
At birth: length 5 ft (1.5 mm)

**DIET**

Fish, squid, and shrimp

**HABITAT**

Coastal

**LIFE HISTORY**

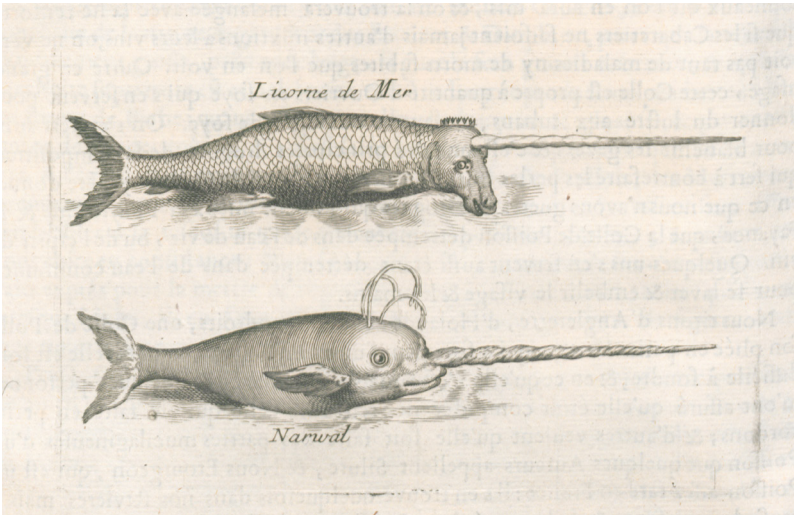
Sexual maturity
Males: 12–20 years
Females: 8–9 years
Gestation: 13–14 months
Reproduce: 3 years

**STATUS**

Least concern
Threat from hunting

ABOVE
A pod of male narwhals, located at Baffin Island, Canada, shows the distinctive black spotting of the body especially around the head, sides, and back.

RIGHT
A narwhal raises its distinctive tusk out of the water.




LEFT
Unicorns (top) and narwhals (bottom) have long been linked. During medieval times narwhals were hunted and their tusks sold as "unicorn horns."

OPPOSITE
Narwhals often raise their tusks in order to "cross swords," sparring with other males for access to females, located at Baffin Island, Canada.

Apart from the distinctive tusk in males, narwhals are characterized by a rotund body, small bulbous head, short blunt flippers, and notched flukes. Narwhals are born gray to brownish gray and they darken to all black with white mottling as they age. Older animals appear nearly white with some black mottling near the front and top of head and appendages.

Narwhals are an Arctic species and are found mainly above the Arctic Circle. They mostly occupy the Atlantic portion of the Arctic although they are occasionally recorded from the Pacific. They migrate annually from open waters in the fall to inshore waters in the spring. In summer narwhals follow the ice along the coast and in winter they remain in pack ice.

Most pods of narwhals consist of two to ten individuals. But there is some evidence that there are groups of larger herds of hundreds or thousands of individuals. There is some age and sex segregation, including all male groups, and nursery groups form commonly.

The diet of narwhals is mainly fish, squid, and shrimp. They mostly feed in the winter in deep water. Dives of 5,000–6,600 feet (1,500–2,000 m) and up to 25 minutes in duration have been reported.

Hunting is the major threat to these animals and native hunters in Canada and Greenland hunt narwhals for their tusks and skin. Narwhals are also victims of ice entrapment, which blocks their escape to the open ocean, and happens more frequently today due to climate warming.

OVERLEAF
Narwhal pod located at the Arctic's ice edge.

# DUGONG AND MANATEES

## Mermaids are based on legends in many cultures of sirens, mythical women that had fish-like bodies resembling a group of sea mammals—manatees and dugongs.

Mermaids are represented as contradictory beings, sometimes even within the same culture. In folklore they are often depicted as dangerous creatures, associated with floods, storms, shipwrecks, and drownings. They have also been portrayed as beautiful creatures, who through the melody of their songs lure sailors into the sea and devour them.

Variations of the word "siren" means mermaid in many languages, and it is the source of the larger group to which manatees (family Trichechidae) and dugongs (family Dugongidae) belong in the order Sirenia.

Since classical antiquity to modern times historical sightings by sailors may have been the result of misunderstood encounters with these aquatic animals. When Christopher Columbus set out to sea in 1492 he had a mermaid sighting of his own, and this encounter was actually the first written record of manatees in North America. Off the coast of Haiti he caught a glimpse of "mermaids," writing in his journal, "On the previous day [8 Jan 1493], when the Admiral went to the Rio del Oro [Haiti], he said he quite distinctly saw three mermaids, which rose well out of the sea…." Indeed, manatees and dugongs are both known to rise out of the sea like the alluring sirens of Greek myth, occasionally performing "tail stands" in shallow water. Likely Columbus saw the Antillean manatee (*Trichechus manatus manatus*), one of two subspecies which ranges from northern Mexico to northern South America including the Caribbean islands.

A Portuguese Renaissance historian António Galvão disseminated observations made in the Spanish New World and wrote referring to the Antillean manatee in 1497, "Is there a fish called manatim; is big and has a cow's head and face, and also in the flesh it looks very like it (…) and the female has breasts with nipples that feeds its children who are born alive." In another example, sixteenth-century missionary and naturalist José de Acosta (1590) refers to the Antillean manatee, "In the islands of Barlavento, namely Spanish Cuba, Puerto Rico, Jamaica, there is the so-called manatee, a strange kind of fish, if one can name fish to an animal, whose cubs are born alive, and has teats, and with milk they are raised, and eats herb in the fields; but indeed, usually resides in the water." European descriptions of the Antillean manatee are based on the botanist Carolus Clusius' knowledge of the Caribbean and his publication illustrating the animal in 1605.

**SIZE**

Manatee: length 8 ft–11 ft (2.5 m–3.5 m); weight 0.5 ton–1.5 tons (0.45 tonne–1.4 tonnes)
Dugong: length 10 ft (3 m); weight 0.6 ton (0.54 tonne)

**DIET**

Seagrasses

**HABITAT**

Shallow subtropical-tropical coastal waters; brackish, marine, and fresh water

**AGE**

50 mya–recent

The West African manatee (*Trichechus senegalensis*) is a vulnerable species, which ranges from Senegal to Angola. It feeds on aquatic plants using its flexible snout and mobile lips to bring food into the mouth.


LEFT
A nineteenth-century hand-colored engraving of a dugong from the Scottish naturalist William Jardine's *Naturalist's Library*. Such illustrations indicate that naturalists were intrigued by these unusual looking creatures.

BELOW
Aboriginal rock art depicting a dugong. This extraordinary artwork was found at Bathurst Head, Queensland, Australia, suggesting that dugongs were common in this area for very many years.

A second subspecies, the Florida manatee (*Trichechus manatus latirostris*) occurs in waters of the southeastern US. Following Columbus's expedition to the Americas, sideshows in Europe advertised "recently discovered" mermaids from the new world, often a dead sirenian.

A description of a mermaid in England's *Magazine of Natural History* is as follows: "A short time back, the skeleton of a mermaid, as it was called, was brought to Portsmouth, which had been shot in the vicinity of the island of Mombass (Kenya). This was allowed to be submitted to the members of the Philosophical Society, when it proved to be the Dugong … It was, if I recollect right, about six feet long: the lower dorsal vertebrae, with the broad caudal extremity, suggested the idea of a powerful fish-like termination; whilst the fore legs, from the scapula to the extremities of the phalanges, presented to the unskillful eye an exact resemblance to the bones of a small female arm." A species of manatee does occur in Africa, *Trichechus senegalensis*, but on the Atlantic side ranging from the Senegal/Mauritania border to central Angola.

In the seventeenth century the Italian missionary Giovanni Cavazzi gives a good description of the so-called fish woman inspired by observations of the African manatee: "There is one [fish] that Europeans call fish-woman and local name is Ngulu-maza [literally, Kikongo or pig water], beautiful name, but so horrendous. Has the muzzle gaping but small in comparison with another that appears to be a male. I think this is the famous triton from fables of mythology, the female may be considered the naiad of the old."

A third manatee species occurs in South America, the Amazonian manatee (*Trichechus inunguis*), an exclusively freshwater species found in the waters of the Amazon River and its tributaries and lakes in Brazil, Guyana, Columbia, Peru, and Ecuador (see page 174). Likely the earliest illustration of this animal was by Brazilian missionary and Frei Cristóvão de Lisboa in 1647, who presented a brief description of the Brazilian manatee accompanied by a good illustration.

Thousands of miles from the seas Columbus sailed, the dugong—found in the Pacific and Indian Oceans—had been living in legend for centuries. In 1959, 3,000-year-old cave drawings were discovered depicting dugongs—the word translates to "lady of the sea" in the Malay language—inside Malaysia's Gui Tambun Cave. In Palau, a Pacific nation of 340 islands, the dugong plays a central role in traditional ceremony and lore. Stories of young women transformed into dugongs endure, and wooden storyboard carvings illustrate dugongs aiding fishermen lost at sea.

# Sea Cow Communities

## Communities of multiple species of sea cows lived together in various ocean regions during different times in the past by partitioning the resources.

Sirenians or sea cows are a group of marine mammals that includes manatees (three species) and the dugong (two species). The world's oceans are characterized today by a single sea cow species living separately in various regions—the dugong occupying the Indian Ocean and manatee species living in the Atlantic. However, in the past it was more common to find several species of sea cows living together. This discovery, termed "multispecies assemblages" by paleontologists Jorge Vélez Juarbe, Nick Pyenson, and Daryl Domning, spurred research to determine the composition, anatomy, and behavior of sea cows in these assemblages.

Vélez-Juarbe and colleagues examined three localities, each from separate time periods (from the late Oligocene of Florida, the early Miocene of India, and the early Pliocene of Mexico) where more than one sea cow species coexisted. They then determined how the species interacted with one another in their environments. To do this, they examined anatomical features that were proxies of dietary preferences in each species. For example, the degree of deflection of the rostrum provides information on whether they were feeding throughout the water column (less downturned rostrum) or were obligatory bottom feeders (more downturned rostrum). Another feature examined was tusk anatomy (size and shape), which provided information on the maximum rhizome or plant stem size that could have been uprooted. Some of these characteristics together with body size estimates (which revealed the amount of seagrasses that could have been ingested) were used to determine how these multispecies assemblages partitioned the resources. Their findings imply that seagrass beds, the animals' principal food source, were different than they are today. Next, they analyzed the evolutionary relationships of all the studied sea cows. The resultant tree showed that the anatomical characters evolved independently in the different sea cow species assemblages. Each fossil assemblage showed species that differed in at least one anatomical feature—rostral deflection, tusk size, and body size allowing their coexistence.

Results indicated that the Oligocene dugongid species from Florida differed in body size and tusk anatomy. The two taxa that have the most similar body sizes (*Crenatosiren olseni* and *Metaxytherium* sp.) differed in having medium and small tusks respectively, whereas the larger bodied form

**SIZE**

Males & females
Length: 5 ft–13 ft (1.5 m–4 m)
Weight: 615 lb–4,103 lb (279 kg–1,866 kg)

**DIET**

Seagrasses

**HABITAT**

Tropical and subtropical shallow waters

**AGE**

26–3 mya

The modern dugong, *Dugong dugon*, is readily distinguished from closely related manatees by a triangular tail used in locomotion and its snout. The dugong's snout is more strongly downturned than the manatees, and reflects the dugong's bottom feeding habit.

(*Dioplotherium manigaulti*) had bigger tusks. The smaller-sized dugongid species were able to feed in shallower waters, and the smaller tusk sizes of these animals suggest that they fed on small plant roots, thereby avoiding food competition with the larger species.

The Indian species all had large tusks but differed in body size and rostral deflection. Two species had similar body sizes (*Domingia sodhae* and *Bharatisiren kachchhensis*) but different rostral deflection. *Domingia* likely uprooted large rhizomes whereas *Bharatisiren* did so to a lesser extent. The smallest of the three species *Kutchisiren cylindrica* showed the greatest rostral deflection, suggesting that it was able to coexist with the others by bottom feeding in very shallow waters.

The Mexican assemblage more closely resembled the Indian species. In the Mexican assemblage two species had large body sizes (*Dioplotherium* sp. and *Corystosiren varguezi*) and another species (*Nanosiren* sp. cf. *N. garciae*) was considerably smaller. Based on tusk size and cranial morphology, there was likely a difference in feeding preference; *Nanosiren* fed on small seagrasses and the two larger bodies species fed on progressively larger seagrasses.

Among the assemblages studied, the Florida species separated by tusk morphology evolved different feeding preferences whereas small body size and strong rostral deflection evolved independently in the Indian and Mexican assemblages. Vélez-Juarbe and colleagues concluded that each multispecies community of sea cows evolved independently from unrelated species of fossil sea cows, yet, each time in different parts of the world, these species separated themselves by utilizing different food resources.

# Rice's Whale

## A new species of baleen whale called Rice's whale was unexpectedly discovered living in the Gulf of Mexico.

Despite being some of the largest animals on the planet, it seems somewhat surprising that we are still discovering new species of whales. In 2003, a new species of baleen whale was discovered, called Omura's whale, *Balaenoptera omurai*, inhabiting the Indo-Pacific and the Atlantic Oceans. In 2019, a 38 feet (11.5 m) baleen whale that washed up near the Florida Everglades was thought to belong to yet another new species—Rice's whale (*Balaenoptera ricei*), named for Dale Rice, long-time NOAA marine mammal scientist. In the 1990s, Rice recognized that a small population of whales was living in the northeastern part of the Gulf of Mexico. At the time the assumption was that it was a subpopulation of Bryde's whales (*Balaenoptera edeni*). In 2008, NOAA scientists conducted a genetic analysis of tissue samples from the mysterious Gulf populations. The analysis suggested that the Gulf population was genetically distinct from other Bryde's whale populations.

The "smoking gun" that would add more evidence to the genetic data would be morphological evidence, such as a skull or other diagnostic skeletal elements. Bones of this new whale were not known until 2019 when a carcass was spotted by a fisherman near Sandy Key in the Florida Everglades National Park. Thanks to efforts of the nearby stranding network, scientists were able to observe the skull anatomy in detail and make comparisons with other Bryde's whales. Peculiarities of the arrangement of the skull bones near the blowhole indicated that the whale specimen differed from Bryde's whale. The newly minted Rice's whale is a bit smaller than Bryde's whale, which can be longer than 50 feet (15 m).

Distributional data indicates that Rice's whale primarily occupy the northeastern Gulf of Mexico along the continental shelf break of the De Soto Canyon area at water depths of 490–1,380 feet (150–420 m). Both males and females breed within the Gulf of Mexico. Individuals are mostly seen alone or in pairs but have been observed in larger loose groups believed to be associated with feeding. Their most commonly recorded prey are pelagic schooling fish.

In addition to genetic and morphologic data, Rice's whales have a unique acoustic signature, most commonly a long moan call type that distinguishes them from other species. In a workshop that provided guidelines for cetacean

**SIZE**

Males & females
Length: up to 41 ft (12.5 m)
Weight: up to 30 tons (27.2 tonnes)

**DIET**

Pelagic schooling fish

**HABITAT**

492 ft–1,345 ft (150 m–410 m) deep

**LIFE HISTORY**

Sexual maturity
Males & females: 9 years
Gestation: 10–12 months
Reproduce: 2–3 years

**STATUS**

Critically endangered
Threats from pollution, ship collision, and underwater noise

*(continued...)*

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