

= Baleen whale =

Baleen whales ( systematic name Mysticeti ), known earlier as whalebone whales , form a parvorder of the infraorder Cetacea ( whales , dolphins and porpoises ) . They are a widely distributed and diverse parvorder of carnivorous marine mammals . Mysticeti comprise the families Balaenidae ( right whales ) , Balaenopteridae ( rorquals ) , Cetotheriidae ( the pygmy right whale ) , and Eschrichtiidae ( the gray whale ) . There are currently 15 species of baleen whale . While cetaceans were historically thought to have descended from mesonychids , molecular evidence supports them as relatives of even @-@ toed ungulates ( Artiodactyla ) . Baleen whales split from toothed whales ( Odontoceti ) around 34 million years ago .

Baleen whales range in size from the 20 ft ( 6 m ) and 6 @,@ 600 lb ( 3 @,@ 000 kg ) pygmy right whale to the 112 ft ( 34 m ) and 190 t ( 210 short tons ) blue whale , which is also the largest creature on earth . They are sexually dimorphic . Baleen whales can have streamlined or large bodies , depending on the feeding behavior , and two limbs that are modified into flippers . Though not as flexible and agile as seals , baleen whales can swim very fast , with the fastest able to travel at 23 miles per hour ( 37 km / h ) . Baleen whales use their baleen plates to filter out food from the water by either lunge @-@ feeding or gulp @-@ feeding . Baleen whales have fused neck vertebrae , and are unable to turn their head at all . Baleen whales have two blowholes . Some species are well adapted for diving to great depths . They have a layer of fat , or blubber , under the skin to keep warm in the cold water .

Although baleen whales are widespread , most species prefer the colder waters around the Northern and Southern poles . Gray whales are specialized for feeding on bottom @-@ dwelling mollusks . Rorquals are specialized at lunge @-@ feeding , and have a streamlined body to reduce drag while accelerating . Right whales gulp @-@ feed , meaning they use their enlarged head to effectively take in a large amount of water and sieve the slow @-@ moving prey . Males typically mate with more than one female ( polygyny ) , although the degree of polygyny varies with the species . Male strategies for reproductive success vary between performing ritual displays ( whale song ) or lek mating . Calves are typically born in the spring and summer months and females bear all the responsibility for raising them . Mothers fast for a relatively long period of time over the period of migration , which varies between species . Baleen whales produce a number of vocalizations , notably the songs of the humpback whale .

The meat , blubber , baleen , and oil of baleen whales have traditionally been used by the indigenous peoples of the Arctic . Once relentlessly hunted by commercial industries for these products , cetaceans are now protected by international law . However , the North Atlantic right whale is ranked critically endangered by the International Union for Conservation of Nature . Besides hunting , baleen whales also face threats from marine pollution and ocean acidification . It has been speculated that man @-@ made sonar results in strandings . They have rarely been kept in captivity , and this has only been attempted with juveniles or members of one of the smallest species .

= = Taxonomy = =

Baleen whales are cetaceans classified under the parvorder Mysticeti , and consist of four extant families : Balaenidae ( right whales ) , Balaenopteridae ( rorquals ) , Cetotheriidae ( pygmy right whale ) , and Eschrichtiidae ( gray whale ) . Balaenids are distinguished by their enlarged head and thick blubber , while rorquals and gray whales generally have a flat head , long throat pleats , and are more streamlined than Balaenids . Rorquals also tend to be longer than the latter . Cetaceans ( whales , dolphins , and porpoises ) and artiodactyls are now classified under the order Cetartiodactyla , often still referred to as Artiodactyla ( given that the cetaceans are deeply nested with the artiodactyls ) . The hippopotamus and pygmy hippopotamus are the closest living relatives to baleen whales , aside from toothed whales , and together with cetaceans form the suborder Whippomorpha .

## == = Classification == =

Balaenidae consists of two genera : Eubalaena ( right whales ) and Balaena ( the bowhead whale , *B. mysticetus* ) . Balaenidae was thought to have consisted of only one genus until studies done through the early 2000s reported that bowhead whales and right whales are morphologically ( different skull shape ) and phylogenically different . According to a study done by H. C. Rosenbaum ( of the American Museum of Natural History ) and colleagues , the North Pacific ( *E. japonica* ) and Southern right ( *E. australis* ) whales are more closely related to each other than to the North Atlantic right whale ( *E. glacialis* ) .

Rorquals consist of two genera ( Balaenoptera and Megaptera ) and nine species : the fin whale ( *B. physalus* ) , the Sei whale ( *B. borealis* ) , Bryde 's whale ( *B. brydei* ) , Eden 's whale ( *B. edeni* ) , the blue whale ( *B. musculus* ) , the common minke whale ( *B. acutorostrata* ) , the Antarctic minke whale ( *B. bonaerensis* ) , Omura 's whale ( *B. omurai* ) , and the humpback whale ( *M. novaeangliae* ) . In a 2012 review of cetacean taxonomy , Alexandre Hassanin ( of the Muséum National d'Histoire Naturelle ) and colleagues suggested that , based on phylogenic criteria , there are four extant genera of rorquals . They recommend that the genus Balaenoptera be limited to the fin whale , have minke whales fall under the genus Pterobalaena , and have Rorqualus contain the Sei whale , Bryde 's whale , Eden 's whale , the blue whale , and Omura 's whale .

Cetotheriidae consists of only one living member : the pygmy right whale ( *Caperea marginata* ) . The first descriptions date back to the 1840s of bones and baleen plates resembling a smaller version of the right whale , and was named Balaena marginata . In 1864 , it was moved into the genus Caperea after a skull of another specimen was discovered . Six years later , the pygmy right whale was classified under the family Neobalaenidae . Despite its name , the pygmy right whale is more genetically similar to rorquals and gray whales than to right whales . A study published in 2012 , based on bone structure , moved the pygmy right whale from the family Neobalaenidae to the family Cetotheriidae , making it a living fossil ; Neobalaenidae was elevated down to subfamily level as Neobalaeninae .

Eschrichtiidae consists of only one living member : the gray whale ( *Eschrichtius robustus* ) . The two populations , one in the Sea of Okhotsk and Sea of Japan and the other in the Mediterranean Sea and East Atlantic , are thought to be genetically and physiologically dissimilar . The gray whale is traditionally placed as the only living species in its genus and family . However , DNA analysis by studies , such as the one by Takeshi Sasaki ( of the Tokyo Institute of Technology ) and colleagues , indicates certain rorquals , such as the humpback whale , Megaptera novaeangliae , and the fin whale , Balaenoptera physalus , are more closely related to the gray whale than they are to some other rorquals , such as the minke whale , Balaenoptera acutorostrata .

## == = Etymology == =

The taxonomic name " Mysticeti " ( / ?m?st?s?ti? / ) apparently derives from a translation error in early copies of Aristotle 's Historia Animalium ( in Ancient Greek ) , in which " ? ??? ?? ????? " ( ho mus to k?tos , " the mouse , the whale so called " ) was mistakenly translated as " ? ?????????? " ( ? mustik?tos , " the Mysticetus " ) , which D. W. Rice ( of the Society for Marine Mammalogy ) in his 1998 work assumed was an ironic reference to the animals ' great size . An alternate name for the parvorder is " Mystacoceti " ( from Greek ?????? " mustache " + ????? " whale " ) , which , although obviously more appropriate and occasionally used in the past , has been superseded by " Mysticeti " ( junior synonym ) .

Mysticetes are also known as baleen whales because of the presence of baleen . These animals rely on their baleen plates to sieve plankton and other small organisms from the water . The term " baleen " ( Middle English baleyn , ballayne , ballien , bellane , etc . ) is an archaic word for " whale " , derived from the Latin word balæna .

Right whales got their name because of whalers preferring them over other species ; they were essentially the " right whale " to catch .

= = = Differences between families = = =

Rorquals use throat pleats to expand their mouth which allows them to feed more effectively . However , rorquals need to build up water pressure in order to expand their mouth , leading to a lunge @-@ feeding behavior . Lunge @-@ feeding is where a whale rams a bait ball ( a swarm of small fish ) at high speeds . Rorquals generally have a streamlined physique to reduce drag in the water while doing this . Balaenids rely on their huge head , as opposed to the rorquals ' throat pleats , to feed effectively . This feeding behavior allows them to grow very big and bulky , without the necessity for a streamlined body . They have callosities , unlike other whales , with the exception of the bowhead whale . Rorquals have a higher proportion of muscle tissue and tend to be negatively buoyant , whereas right whales have a higher proportion of blubber and are positively buoyant . The gray whale is easily distinguished from other extant cetaceans by its sleet @-@ gray color , a dorsal ridge ( knuckles on the back ) , and its gray @-@ white scars left from parasites . Like in the rorquals , their throat pleats increase the capacity of their throat , allowing them to filter larger volumes of water at once . Gray whales are bottom @-@ feeders , meaning they sift through sand to get their food . They usually turn on their side and scoop up sediment into their mouth and filter out benthic creatures like amphipods , which leaves a noticeable mark on their head . The pygmy right whale is easily confused with minke whales because of their similar characteristics , such as its small size , throat pleats , dark gray top , light gray bottom , and a light eye @-@ patch .

= = = Evolutionary history = = =

Mysticeti split from Odontoceti ( toothed whales ) 34 million years ago during the Eocene . Their evolutionary link to archaic toothed cetaceans ( Archaeoceti ) remained unknown until the extinct Janjucetus hunderi was discovered in the early 1990s in Victoria , Australia . Like a modern baleen whale , Janjucetus had baleen in its jaw and had very little biosonar capabilities . However , its jaw also contained teeth , with incisors and canines built for stabbing and molars and premolars built for tearing . These early mysticetes were exceedingly small compared to modern baleen whales , with species like Mammalodon measuring no greater than 10 feet ( 3 m ) . It is thought that their size increased with their dependence on baleen . The discovery of Janjucetus and others like it suggests that baleen evolution went through several transitional phases . Species like Mammalodon colliveri had little to no baleen , while later species like Aetiocetus weltoni had both baleen and teeth , suggesting they had limited filter feeding capabilities ; later genera like Cetotherium had no teeth in their mouth , meaning they were fully dependent on baleen and could only filter feed .

Fucaia buelli is the earliest mysticete , dating back to 33 million years ago ( mya ) . Measuring only 6 @.@ 6 feet ( 2 m ) , it is the smallest extant baleen whale . It is only known from its teeth ; they suggest a suction feeding behavior , much like that of beaked whales . Like other early toothed mysticetes , or " archaeomysticetes " , F. buelli had heterodont dentition . Archaeomysticetes from the Oligocene are the Mammalodontidae ( Mammalodon and Janjucetus ) from Australia . They were small with shortened rostra , and a primitive dental formula ( 3 @.@ 1 @.@ 4 @.@ 33 @.@ 1 @.@ 4 @.@ 3 ) . In baleen whales , enlarged mouths adapted for suction feeding evolved before specializations for bulk filter feeding . In the toothed Oligocene mammalodontid Janjucetus , the symphysis is short and the mouth enlarged , the rostrum is wide , and the edges of the maxillae are thin , indicating an adaptation for suction feeding . The aetiocetid Chonecetus still had teeth , but the presence of a groove on the interior side of each mandible indicates the symphysis was elastic , which would have enabled rotation of each mandible , an initial adaptation for bulk feeding like in modern mysticetes .

The lineages of rorquals and right whales split almost 20 mya . It is unknown where this occurred , but it is generally believed that they , like their descendants , followed plankton migrations . These primitive mysticetes had lost their heterodont dentition in favor of baleen , and are believed to have lived on a specialized benthic , plankton , or copepod diet like modern mysticetes . Mysticetes experienced their first radiation in the mid @-@ Miocene . Balaenopterids grew bigger during this time , with species like Balaenoptera sibbaldina rivaling the blue whale in terms of size . It is thought

this radiation was caused by global climate change and major tectonic activity ( the Antarctic Circumpolar Current ) .

The first toothless ancestors of Mysticetes appeared before the first radiation in the late Oligocene . Eomysticetus and others like it showed no evidence in the skull of echolocation abilities , suggesting they mainly relied on their eyesight for navigation . The eomysticetes had long , flat rostra that lacked teeth and had external nares located halfway up the dorsal side of the snout . Though the palate is not well @-@ preserved in these specimens , they are thought to have had baleen and been filter feeders . Miocene baleen whales were preyed upon by larger predators like killer sperm whales and Megalodon .

= = Anatomy = =

= = = Motion = = =

When swimming , baleen whales rely on their flippers for locomotion in a wing @-@ like manner similar to penguins and sea turtles . Flipper movement is continuous . While doing this , baleen whales use their tail fluke to propel themselves forward through vertical motion while using their flippers for steering , much like an otter . Some species leap out of the water , which may allow them to travel faster . Because of their great size , baleen whales are not flexible or agile like dolphins , and none can move their neck because of the fused cervical vertebrae ; this sacrifices speed for stability in the water . The hind legs are enclosed inside the body , and are thought to be vestigial organs . However , a 2014 study suggests that the pelvic bone serves as support for whale genitalia .

Rorquals , needing to build speed to feed , have several adaptations for reducing drag , including a streamlined body ; a small dorsal fin , relative to its size ; and lack of external ears or long hair . The fin whale , the fastest among baleen whales , can travel at 23 miles per hour ( 37 km / h ) . While feeding , the rorqual jaw expands to a volume that can be bigger than the whale itself ; to do this , the mouth inflates . The inflation of the mouth causes the cavum ventrale , the throat pleats on the underside stretching to the navel , to expand , increasing the amount of water that the mouth can store . The mandible is connected to the skull by dense fibers and cartilage ( fibrocartilage ) , allowing the jaw to swing open at almost a 90 ° angle . The mandibular symphysis is also fibrocartilaginous , allowing the jaw to bend which lets in more water . To prevent stretching the mouth too far , rorquals have a sensory organ located in the middle of the jaw to regulate these functions .

= = = External anatomy = = =

Baleen whales have two flippers on the front , near the head . Like all mammals , baleen whales breathe air and must surface periodically to do so . Their nostrils , or blowholes , are situated at the top of the cranium . Baleen whales have two blowholes , as opposed to toothed whales which have one . These paired blowholes are longitudinal slits that converge anteriorly and widen posteriorly , which causes a V @-@ shaped blow . They are surrounded by a fleshy ridge that keeps water away while the whale breathes . The septum that separates the blowholes has two plugs attached to it , making the blowholes water @-@ tight while the whale dives .

Like other mammals , the skin of baleen whales has an epidermis , a dermis , a hypodermis , and connective tissue . The epidermis , the pigmented layer , is 0 @-@ 2 inches ( 5 mm ) thick , along with connective tissue . The epidermis itself is only 0 @-@ 04 inches ( 1 mm ) thick . The dermis , the layer underneath the epidermis , is also thin . The hypodermis , containing blubber , is the thickest part of the skin and functions as a means to conserve heat . Right whales have the thickest hypodermis of any cetacean , averaging 20 inches ( 51 cm ) , though , as in all whales , it is thinner around openings ( such as the blowhole ) and limbs . Blubber may also be used to store energy during times of fasting . The connective tissue between the hypodermis and muscles allows only

limited movement to occur between them . Unlike in toothed whales , baleen whales have small hairs on the top of their head , stretching from the tip of the rostrum to the blowhole , and , in right whales , on the chin . Like other marine mammals , they lack sebaceous and sweat glands .

The baleen of baleen whales are keratinous plates . They are made of a calcified hard ? @-@ keratin material , a fiber @-@ reinforced structure made of intermediate filaments ( proteins ) . The degree of calcification varies between species , with the sei whale having 14 @.@ 5 % hydroxyapatite , a mineral that coats teeth and bones , whereas minke whales have 1 ? 4 % hydroxyapatite . In most mammals , keratin structures , such as wool , air @-@ dry , but aquatic whales rely on calcium salts to form on the plates to stiffen them . Baleen plates are attached to the upper jaw and are absent in the mid @-@ jaw , forming two separate combs of baleen . The plates decrease in size as they go further back into the jaw ; the largest ones are called the " main baleen plates " and the smallest ones are called the " accessory plates " . Accessory plates taper off into small hairs .

Unlike other whales ( and most other mammals ) , the females are larger than the males . Sexual dimorphism is usually reversed , with the males being larger , but the females of all baleen whales are usually five percent larger than males . Sexual dimorphism is also displayed through whale song , notably in humpback whales where the males of the species sing elaborate songs . Male right whales have bigger callosities than female right whales . The males are generally more scarred than females which is thought to be because of aggression during mating season .

= = = Internal systems = = =

The unique lungs of baleen whales are built to collapse under the pressure instead of resisting the pressure which would damage the lungs , enabling some , like the fin whale , to dive to a depth of ? 1 @,@ 540 feet ( ? 470 m ) . The whale lungs are very efficient at extracting oxygen from the air , usually 80 % , whereas humans only extract 20 % of oxygen from inhaled air . Lung volume is relatively low compared to terrestrial mammals because of the inability of the respiratory tract to hold gas while diving . Doing so may cause serious complications such as embolism . Unlike other mammals , the lungs of baleen whales lack lobes and are more sacculated . Like in humans , the left lung is smaller than the right to make room for the heart . To conserve oxygen , blood is rerouted from pressure @-@ tolerant @-@ tissue to internal organs , and they have a high concentration of myoglobin which allows them to hold their breath longer .

The heart of baleen whales functions similarly to other mammals , with the major difference being the size . The heart can reach 1 @,@ 000 pounds ( 454 kg ) , but is still proportional to the whale 's size . The muscular wall of the ventricle , which is responsible for pumping blood out of the heart , can be 3 to 5 inches ( 7 @.@ 6 to 12 @.@ 7 cm ) thick . The aorta , an artery , can be .75 inches ( 1 @.@ 9 cm ) thick . Their resting heart rate is 60 to 140 beats per minute ( bpm ) , as opposed to the 60 to 100 bpm in humans . When diving , their heart rate will drop to 4 to 15 bpm to conserve oxygen . Like toothed whales , they have a dense network of blood vessels ( rete mirabile ) which prevents heat @-@ loss . Like in most mammals , heat is lost in their extremities , so , in baleen whales , warm blood in the arteries is surrounded by veins to prevent heat loss during transport . As well as this , heat inevitably given off by the arteries warms blood in the surrounding veins as it travels back into the core . This is otherwise known as countercurrent exchange . To counteract overheating while in warmer waters , baleen whales reroute blood to the skin to accelerate heat @-@ loss . They have the largest blood corpuscles ( red and white blood cells ) of any mammal , measuring 4 @.@ 1 × 10 ? 4 inches ( 10 μm ) in diameter , as opposed to human 's 2 @.@ 8 × 10 ? 4 @-@ inch ( 7 @.@ 1 μm ) blood corpuscles .

When sieved from the water , food is swallowed and travels through the esophagus where it enters a three @-@ chambered @-@ stomach . The first compartment is known as the fore @-@ stomach ; this is where food gets ground up into an acidic liquid , which is then squirted into the main stomach . Like in humans , the food is mixed with hydrochloric acid and protein @-@ digesting enzymes . Then , the partly digested food is moved into the third stomach , where it meets fat @-@ digesting enzymes , and is then mixed with an alkaline liquid to neutralize the acid from the fore

@-@ stomach to prevent damage to the intestinal tract . Their intestinal tract is highly adapted to absorb the most nutrients from food ; the walls are folded and contain copious blood vessels , allowing for a greater surface area over which digested food and water can be absorbed . Baleen whales get the water they need from their food ; however , the salt content of most of their prey ( invertebrates ) are similar to that of seawater , whereas the salt content of a whale 's blood is considerably lower ( three times lower ) than that of seawater . The whale kidney is adapted to excreting excess salt ; however , while producing urine more concentrated than seawater , it wastes a lot of water which must be replaced .

Baleen whales have a relatively small brain compared to their body mass . Like other mammals , their brain has a large , folded cerebrum , the part of the brain responsible for memory and processing sensory information . Their cerebrum only makes up about 68 % of their brain 's weight , as opposed to human 's 83 % . The cerebellum , the part of the brain responsible for balance and coordination , makes up 18 % of their brain 's weight , compared to 10 % in humans , which is probably due to the great degree of control necessary for constantly swimming . Necropsies on the brains of gray whales revealed iron oxide particles , which may allow them to find magnetic north like a compass .

Unlike most animals , whales are conscious breathers . All mammals sleep , but whales cannot afford to become unconscious for long because they may drown . They are believed to exhibit unihemispheric slow @-@ wave sleep , in which they sleep with half of the brain while the other half remains active . This behavior was only documented in toothed whales until footage of a humpback whale sleeping ( vertically ) was shot in 2014 .

It is largely unknown how baleen whales produce sound because of the lack of a melon and vocal cords . In a 2007 study , it was discovered that the larynx had U @-@ shaped folds which are thought to be similar to vocal cords . They are positioned parallel to air flow , as opposed to the perpendicular vocal cords of terrestrial mammals . These may control air flow and cause vibrations . The walls of the larynx are able to contract which may generate sound with support from the arytenoid cartilages . The muscles surrounding the larynx may expel air rapidly or maintain a constant volume while diving .

#### = = = Senses = = =

The eyes of baleen whales are relatively small for their size and are positioned near the end of the mouth . This is probably because they feed on slow or immobile prey , combined with the fact that most sunlight does not pass 30 feet ( 9 @.@ 1 m ) , and hence they do not need acute vision . A whale 's eye is adapted for seeing both in the euphotic and aphotic zones by increasing or decreasing the pupil 's size to prevent damage to the eye . As opposed to land mammals which have a flattened lens , whales have a spherical lens . The retina is surrounded by a reflective layer of cells ( tapetum lucidum ) , which bounces light back at the retina , enhancing eyesight in dark areas . However , light is bent more near the surface of the eye when in air as opposed to water ; consequently , they can see much better in the air than in the water . The eyeballs are protected by a thick outer layer to prevent abrasions , and an oily fluid ( instead of tears ) on the surface of the eye . Baleen whales appear to have limited color vision , as they lack S @-@ cones .

The mysticete ear is adapted for hearing underwater , where it can hear sound frequencies as low as 7 Hz and as high as 22 kHz , with the exception of the 52 @-@ hertz whale . It is largely unknown how sound is received by baleen whales . Unlike in toothed whales , sound does not pass through the lower jaw . The auditory meatus is blocked by connective tissue and an ear plug , which connects to the eardrum . The inner @-@ ear bones are contained in the tympanic bulla , a bony capsule . However , this is attached to the skull , suggesting that vibrations passing through the bone is important . Sinuses may reflect vibrations towards the cochlea . It is known that when the fluid inside the cochlea is disturbed by vibrations , it triggers sensory hairs which send electrical current to the brain , where vibrations are processed into sound .

Baleen whales have a small , yet functional , vomeronasal organ . This allows baleen whales to detect chemicals and pheromones released by their prey . It is thought that ' tasting ' the water is

important for finding prey , and track down other whales . They are believed to have an impaired sense of smell due to the lack of the olfactory bulb , but they do have an olfactory tract . Baleen whales have few if any taste buds , suggesting they have lost their sense of taste . They do retain salt @-@ receptor taste @-@ buds suggesting that they can taste saltiness .

= = Behavior = =

= = = Migration = = =

It is thought that plankton blooms dictate where whales migrate . This usually occurs in the polar regions during the sunny spring and summer months , bringing along other plankton such as euphausiids which whales feed on . They also migrate to calving grounds in tropical waters during the winter months when plankton populations are low . As well as this , newborns , with underdeveloped blubber , would likely die of frostbite in the winter temperatures . It is also postulated by a 2008 study that these take place to avoid calves being predated on by killer whales . The migration cycle is repeated annually . The gray whale has the longest recorded migration of any mammal , with one traveling 14 @,@ 000 miles ( 23 @,@ 000 km ) from the Sea of Okhotsk to the Baja Peninsula .

= = = Foraging = = =

All baleen whales are carnivorous ; however a 2015 study revealed they house gut flora similar to that of terrestrial herbivores . Different kinds of prey are found in different abundances depending on location , and each type of whale is adapted to a specialized way of foraging . There are two types of feeding behaviors : gulp @-@ feeding and lunge @-@ feeding , but some species do both depending on the type and amount of food . For example , Antarctic residents mostly feed on Euphausiids ; however , this is mainly effective for lunge @-@ feeders , whereas gulp @-@ feeders , like the right whales , feed primarily on copepods . They feed alone or in small groups . Baleen whales get the water they need from their food , and their kidneys excrete excess salt .

The lunge @-@ feeders are the rorquals and the pygmy right whale . To feed , lunge @-@ feeders expand the volume of their jaw to a volume bigger than the original volume of the whale itself ; to do this , the mouth inflates to expand the mouth . The inflation of the mouth causes the throat pleats to expand , increasing the amount of water that the mouth can store . Just before they ram the baitball , the jaw swings open at almost a 90 ° angle and bends which lets in more water . To prevent stretching the mouth too far , rorquals have a sensory organ located in the middle of the jaw to regulate these functions . Then they must decelerate . This process takes a lot of mechanical work , and is only energy @-@ effective when used against a large baitball . The gulp @-@ feeders , or skim @-@ feeders , are right whales and gray whales . To feed , gulp @-@ feeders swim with an open mouth , filling it with water and prey . Prey must occur in sufficient numbers to trigger the whale 's interest , be within a certain size range so that the baleen plates can filter it , and be slow enough so that it cannot escape . The " skimming " may take place on the surface , underwater , or even at the ocean 's bottom , indicated by mud occasionally observed on right whales ' bodies . Gray whales feed primarily on the ocean 's bottom , feeding on benthic creatures .

= = = Predation and parasitism = = =

Adult baleen whales , because of their great size , do not have any natural predators . However , calves can be preyed on by the killer whale . It is thought that annual whale migration occurs to protect the calves from the killer whales . There have also been reports of a pod of killer whales attacking and killing an adult bowhead whale , by holding down its flippers , covering the blowhole , and ramming and biting until death . Generally , a mother and calf pair , when faced with the threat of a killer whale pod , will either fight or flee . Fleeing only occurs in species that can swim away

quickly , the rorquals . Slower whales must fight the pod alone or with a small family group . There has been one report of a shark attacking and killing a whale calf . This occurred in 2014 during the sardine run when a shiver of dusky sharks attacked a humpback whale calf . Usually , the only shark that will attack a whale is the cookie cutter shark , which leaves a small , non @-@ fatal bite mark .

Many parasites latch onto whales , notably whale lice and whale barnacles . Almost all species of whale lice are specialized towards a certain species of whale , and there can be more than one species per whale . Whale lice eat dead skin , resulting in minor wounds in the skin . Whale louse infestations are especially evident in right whales , where colonies propagate on their callosities . Though not a parasite , whale barnacles latch onto the skin of a whale during their larval stage . However , in doing so it does not harm nor benefit the whale , so their relationship is often labeled as an example of commensalism . Some baleen whales will deliberately rub themselves on substrate to dislodge parasites . Some species of barnacle , such as *Conchoderma auritum* and whale barnacles , attach to the baleen plates , though this seldom occurs . A species of copepod , *Balaenophilus unisetus* , inhabits baleen plates of whales in tropical waters . A species of Antarctic diatom , *Cocconeis ceticola* , forms a film on the skin , which takes a month to develop ; this film causes minor damage to the skin . They are also plagued by internal parasites such as stomach worms , cestodes , nematodes , liver flukes , and acanthocephalans .

### == = Reproduction and development == =

Before reaching adulthood , baleen whales grow at an extraordinary rate . In the blue whale , the largest species , the fetus grows by some 220 lb ( 100 kg ) per day just before delivery , and by 180 lb ( 80 kg ) per day during suckling . Before weaning , the calf increases its body weight by 17 t ( 17 long tons ; 19 short tons ) and grows from 23 to 26 ft ( 7 to 8 m ) at birth to 43 to 52 ft ( 13 to 16 m ) long . When it reaches sexual maturity after 5 ? 10 years , it will be 66 to 79 ft ( 20 to 24 m ) long and possibly live as long as 80 ? 90 years . Calves are born precocial , needing to be able to swim to the surface at the moment of their birth .

Most rorquals mate in warm waters in winter to give birth almost a year later . A 7 @-@ to @-@ 11 month lactation period is normally followed by a year of rest before mating starts again . Adults normally start reproducing when 5 ? 10 years old and reach their full length after 20 ? 30 years . In the smallest rorqual , the minke whale , 10 ft ( 3 m ) calves are born after a 10 @-@ month pregnancy and weaning lasts until it has reached about 16 to 18 ft ( 5 to 5 @-@ 5 m ) after 6 ? 7 months . Unusual for a baleen whale , female minkes ( and humpbacks ) can become pregnant immediately after giving birth ; in most species , there is a two @-@ to @-@ three @-@ year calving period . In right whales , the calving interval is usually three years . They grow very rapidly during their first year , after which they hardly increase in size for several years . They reach sexual maturity when 43 to 46 ft ( 13 to 14 m ) long . Baleen whales are K @-@ strategists , meaning they raise one calf at a time , have a long life @-@ expectancy , and a low infant mortality rate . Some 19th century harpoons found in harvested bowheads indicate this species can live more than 100 years . Baleen whales are promiscuous , with none showing pair bonds . They are polygynous , in that a male may mate with more than one female . The scars on male whales suggest they fight for the right to mate with females during breeding season , somewhat similar to lek mating .

Baleen whales have fibroelastic ( connective tissue ) penises , similar to those of artiodactyls . The tip of the penis , which tapers toward the end , is called the pars intrapraeputialis or terminal cone . The blue whale has the largest penis of any organism on the planet , typically measuring 8 ? 10 feet ( 2 @-@ 4 ? 3 @-@ 0 m ) . Accurate measurements of the blue whale are difficult to take because the whale 's erect length can only be observed during mating . The penis on a right whale can be up to 2 @-@ 7 m ( 8 @-@ 9 ft ) ? the testes , at up to 2 m ( 6 @-@ 6 ft ) in length , 78 cm ( 2 @-@ 56 ft ) in diameter , and weighing up to 525 lb ( 238 kg ) , are also the largest of any animal on Earth .

### == = Whale song == =

All baleen whales use sound for communication and are known to " sing " , especially during the



breeding season . Blue whales produce the loudest sustained sounds of any animals : their low @-@ frequency ( about 20 Hz ) moans can last for half a minute , reach almost 190 decibels , and be heard hundreds of kilometers away . Adult male humpbacks produce the longest and most complex songs ; sequences of moans , groans , roars , sighs , and chirps sometimes lasting more than ten minutes are repeated for hours . Typically , all humpback males in a population sing the same song over a breeding season , but the songs change slightly between seasons , and males in one population have been observed adapting the song from males of a neighboring population over a few breeding seasons .

= = = Intelligence = = =

Unlike their toothed whale counterparts , baleen whales are hard to study because of their immense size . Intelligence tests such as the mirror test cannot be done because their bulk and lack of body language makes a reaction impossible to be definitive . However , studies on the brains of humpback whales revealed spindle cells , which , in humans , control theory of mind . Because of this , it is thought that baleen whales , or at least humpback whales , have consciousness .

= = Relationship with humans = =

= = = History of whaling = = =

Whaling by humans has existed since the Stone Age . Ancient whalers used harpoons to spear the bigger animals from boats out at sea . People from Norway started hunting whales around 4 @,@ 000 years ago , and people from Japan began hunting whales in the Pacific at least as early as that . Whales are typically hunted for their meat and blubber by aboriginal groups ; they used baleen for baskets or roofing , and made tools and masks out of bones . The Inuit hunted whales in the Arctic Ocean . The Basques started whaling as early as the 11th century , sailing as far as Newfoundland in the 16th century in search of right whales . 18th and 19th century whalers hunted down whales mainly for their oil , which was used as lamp fuel and a lubricant , and baleen ( or whalebone ) , which was used for items such as corsets and skirt hoops . The most successful whaling nations at this time were the Netherlands , Japan , and the United States .

Commercial whaling was historically important as an industry well throughout the 19th and 20th centuries . Whaling was at that time a sizable European industry with ships from Britain , France , Spain , Denmark , the Netherlands , and Germany , sometimes collaborating to hunt whales in the Arctic . By the early 1790s , whalers , namely the British ( Australian ) and Americans , started to focus efforts in the South Pacific ; in the mid 1900s , over 50 @,@ 000 humpback whale were taken from the South Pacific . At its height in the 1880s , U.S. profits turned to USD10,000,000 , equivalent to USD225,000,000 today . Commonly exploited species included arctic whales such as the gray whale , right whale , and bowhead whale because they were close to the main whaling ports , like New Bedford . After those stocks were depleted , rorquals in the South Pacific were targeted by nearly all whaling organizations ; however , they often out @-@ swam whaling vessels . Whaling rorquals was not effective until the harpoon cannon was invented in the late 1860s . Whaling basically stopped when stocks of all species were depleted to a point that they could not be harvested on a commercial scale . Whaling was controlled in 1982 when the International Whaling Commission ( IWC ) placed a moratorium setting catch limits to protect species from dying out from over @-@ exploitation , and eventually banned it :

Notwithstanding the other provisions of paragraph 10 , catch limits for the killing for commercial purposes of whales from all stocks for the 1986 coastal and the 1985 / 86 pelagic seasons and thereafter shall be zero . This provision will be kept under review , based upon the best scientific advice , and by 1990 at the latest the Commission will undertake a comprehensive assessment of the effects of this decision on whale stocks and consider modification of this provision and the establishment of other catch limits .

? IWC Commission Schedule , paragraph 10 ( e )

= = = Conservation and management issues = = =

As of 2013 , the International Union for Conservation of Nature ( IUCN ) recognizes 15 mysticete species . One species ? the North Atlantic right whale ? is Endangered with only around 400 (  $\pm 50$  ) individuals left , and four more are also classified as Endangered ( North Pacific right whale , the blue whale , the fin whale , and the Sei whale ) , and another 5 ranked as Data deficient ( Bryde 's whale , Eden 's whale , Omura 's whale , Southern minke whale , and pygmy right whale ) . Species that live in polar habitats are vulnerable to the effects of ongoing climate change , particularly declines in sea ice , as well as ocean acidification .

The whale watching industry and anti @-@ whaling advocates argue that whaling catches " friendly " whales that are curious about boats , as these whales are the easiest to catch . This analysis claims that once the economic benefits of hotels , restaurants and other tourist amenities are considered , hunting whales is a net economic loss . This argument is particularly contentious in Iceland , as it has among the most @-@ developed whale @-@ watching operations in the world and the hunting of minke whales resumed in August 2003 . Brazil , Argentina and South Africa argue that whale watching is a growing billion @-@ dollar industry that provides more revenue than commercial whaling would provide . Peru , Uruguay , Australia , and New Zealand also support proposals to permanently forbid whaling south of the Equator , as Solor ( an island of Indonesia ) is the only place of the Southern Hemisphere that takes whales . Anti @-@ whaling groups claim that developing countries which support a pro @-@ whaling stance are damaging their economies by driving away anti @-@ whaling tourists .

Commercial whaling was historically important for the world economy . All species were exploited , and as one type 's stock depleted , another type was targeted . The scale of whale harvesting decreased substantially through the 1960s as all whale stocks had been depleted , and practically stopped in 1988 after the International Whaling Commission placed a moratorium which banned whaling for commercial use . Several species that were commercially exploited have rebounded in numbers ; for example , gray whales may be as numerous as they were prior to whaling , making it the first marine mammal to be taken off the Endangered species list . The Southern right whale was hunted to near extinction in the mid @-@ to @-@ late 20th century , with only a small ( unknown ) population around Antarctica . Because of international protection , the Southern right whale 's population has been growing 7 % annually since 1970 . Conversely , the eastern stock of North Atlantic right whale was extirpated from much of its former range , which stretched from the coast of North Africa to the North Sea and Iceland ; it is thought that the entire stock consists of only ten individuals , making the eastern stock functionally extinct .

Baleen whales continue to be harvested . However , only three nations take whales : Iceland , Norway , and Japan . All these nations are part of the IWC , with Norway and Iceland rejecting the moratorium and continuing commercial whaling . Japan , being part of the IWC , whales under the Scientific Permit stated in Article VIII in the Convention for the Regulation of Whaling , which allows the taking of whales for scientific research . Japan has had two main research programs : the Joint Aquatic Resources Permit Application ( JARPA ) and the Japanese Research Program in the North ( JARPN ) . JARPN is focused in the North Pacific and JARPA around the Antarctic . JARPA mainly caught Antarctic minke whales , catching nearly 7 @, @ 000 ; to a far lesser extent , they also caught fin whales . Animal @-@ rights activist groups , such as the Greenpeace , object to Japan 's scientific whaling , with some calling it a substitute for commercial whaling . In 2014 , the International Court of Justice ( the UN judicial branch ) banned the taking of whales for any purpose in the Southern Ocean Whale Sanctuary ; however , Japan refuses to stop whaling and has only promised to cut their annual catches by a third ( around 300 whales per year ) .

Baleen whales can also be affected by humans in more indirect ways . For species like the North Atlantic right whale , which migrates through some of the world 's busiest shipping lanes , the biggest threat is from being struck by ships . The Lloyd 's mirror effect results in low frequency propeller sounds not being discernible near the surface , where most accidents occur . Combined

with spreading and acoustic shadowing effects , the result is that the whale is unable to hear an approaching vessel before it has been run over or entrapped by the hydrodynamic forces of the vessel 's passage . A 2014 study noted that a lower vessel speed correlated with lower collision rates . The ever @-@ increasing amount of ocean noise , including sonar , drowns out the vocalizations produced by whales , notably in the blue whale which produces the loudest vocalization , which makes it harder for them to communicate . Blue whales stop producing foraging D calls once a mid @-@ frequency sonar is activated , even though the sonar frequency range ( 1 ? 8 kHz ) far exceeds their sound production range ( 25 ? 100 Hz ) . Poisoning from toxic substances such as Polychlorinated biphenyl ( PCB ) is generally low because of their low trophic level . Some baleen whales can become victims of bycatch , which is especially serious for North Atlantic right whales considering there are only 450 left . Right whales feed with a wide @-@ open mouth , risking entanglement in any rope or net fixed in the water column . Rope wraps around their upper jaw , flippers and tail . Some are able to escape , but others remain entangled . If observers notice , they can be successfully disentangled , but others die over a period of months . Other whales , such as humpback whales , can also be entangled .

= = = In captivity = = =

Baleen whales have rarely been kept in captivity . Their large size and appetite make them expensive creatures to maintain . Pools of proper size would also be very expensive to build . For example , a single gray whale calf would need to eat 475 pounds ( 215 kg ) of fish per day , and the pool would have to accommodate the 13 @-@ foot ( 4 m ) calf , along with ample room to swim . Only two species have survived being kept in captivity for over a year : gray whales and minke whales . The first gray whale , who was captured in Scammon 's Lagoon , Baja California Sur , in 1965 , was named Gigi and died two months later from an infection . The second gray whale , who was captured in 1972 from the same lagoon , was named Gigi II and was released a year later after becoming too big . The last gray whale , J.J. , beached herself in Marina del Rey , California , where she was rushed to SeaWorld San Diego and , after 14 months , was released because she got too big to take care of . Reaching 19 @,@ 200 pounds ( 8 @,@ 700 kg ) and 31 feet ( 9 @.@ 4 m ) , J.J. was the largest creature to be kept in captivity . The Mito Aquarium in Numazu , Shizuoka , Japan , housed three minke whales in the nearby bay enclosed by nets . One survived for three months , another ( a calf ) survived for two weeks , and another was kept for a year before breaking through the nets .