

# **BALEEN WHALES**

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## CONTENTS

Scientific Classification .....	1
Habitat and Distribution .....	3
Physical Characteristics .....	6
Senses .....	11
Adaptations for an Aquatic Environment .....	13
Behavior .....	16
Diet and Eating Habits .....	17
Reproduction .....	20
Communication .....	22
Longevity and Causes of Death .....	23
Conservation .....	25

## BALEEN WHALES

### SCIENTIFIC CLASSIFICATION

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- A. Class Mammalia. Mammals are characterized by the following features:
1. Mammals breathe air with lungs.
  2. Mammals are “warm-blooded”: they maintain a constant, high body temperature independent of their surroundings.
  3. As a rule, mammals bear live young. (Two primitive mammals are exceptions to this rule: the duckbilled platypus and the spiny anteater both lay eggs.)
  4. Mammals nurse their young with milk.
  5. Mammals have hair, at least at some stage in their development. Many baleen whales have sparse hairs on the snout, jaws, and chin.
- B. Order Cetacea.
1. Cetacea is a scientific order of large aquatic mammals that have forelimbs modified into flippers, a horizontally flattened tail, a nostril at the top of the head for breathing, and no hind limbs. Cetaceans include all whales, dolphins and porpoises.
  2. The word “cetacean” is derived from the Greek word for whale, *kētos*.
  3. Living cetaceans are further divided into two suborders: the Odontoceti (toothed whales) and the Mysticeti (baleen whales).
- C. Suborder Mysticeti.
- Mysticeti is a scientific suborder of whales that have plates of baleen in the upper jaw. The word “mysticete” may be derived from the Greek word for moustache, *mystakos*. It may refer to the hairy appearance of these whale’s baleen plates. Baleen whales are sometimes referred to as the “great whales.”
- D. Mysticete families, genera and species.
1. Family Balaenopteridae (the rorqual whales). Rorqual (from the Norwegian, *rørhval*) whales have extremely long, streamlined bodies with many longitudinal grooves along the skin of the throat. A rorqual whale has a small dorsal fin and short (compared with other baleen whales) baleen plates.

#### Family Balaenopteridae: the rorqual whales

minke whale (*Balaenoptera acutorostrata*)\*

Sei whale (*Balaenoptera borealis*)

Bryde's whale (*Balaenoptera edeni*)  
blue whale (*Balaenoptera musculus*)\*\*  
fin whale (*Balaenoptera physalus*)  
humpback whale (*Megaptera novaeangliae*)

\* Some scientists identify three geographically isolated populations of minke whales that may be separate subspecies:

- *Balaenoptera acutorostrata acutorostrata* (North Atlantic)
- *Balaenoptera acutorostrata bonarensis* (southern hemisphere)
- *Balaenoptera acutorostrata davidsonii* (North Pacific)

\*\* Some scientists identify three subspecies of blue whale:

- *Balaenoptera musculus breviceuda* (pygmy blue whale of subantarctic Indian Ocean and southeastern Atlantic Ocean)
- *Balaenoptera musculus musculus* (northern hemisphere)
- *Balaenoptera musculus intermedia* (southern hemisphere)

2. Family Balaenidae (the right whales). A right whale has a smooth throat and a disproportionately large head with very long baleen plates in a hugely arched jaw. With the exception of the pygmy right whale (*Caperea marginata*) whales in this family do not have dorsal fins. Right whales were so named by whalers who deemed them the "right" whales to hunt.

Family Balaenidae: the right whales

bowhead whale (*Balaena mysticetus*)  
pygmy right whale (*Caperea marginata*)  
northern right whale (*Eubalaena glacialis*)  
southern right whale (*Eubalaena australis*)

3. Family Eschrichtiidae (the gray whale). A gray whale has a few throat grooves, short baleen plates, and a small dorsal hump followed by a series of bumps. This family has one living member, the gray whale (*Eschrichtius robustus*).

Family Eschrichtidae

gray whale (*Eschrichtius robustus*)

4. Most scientists recognize three families of baleen whales. Some recognize a fourth family, Neobalaenidae, which includes only the pygmy right whale *Caperea marginata*. This whale has characteristics of both rorquals and right whales: its head is not as disproportionately large as that of other right whales; it has a small dorsal fin; and it has two rather indistinct grooves along the skin of its throat.

- E. Fossil record.
1. Scientists believe that early whales arose about 55 to 65 million years ago from (now extinct) ancient land mammals that ventured into the sea. These ancestors of present-day whales had some adaptations for an aquatic life. Scientists agree that ancestors of both toothed and baleen whales probably had teeth.
  2. Fossils indicate that the earliest known baleen whales lived about 30 million years ago. By 25 million years ago, early members of the right whale family appeared. Members of the rorqual family appeared about 15 million years ago, including the modern genus *Megaptera*.
  3. Most modern forms of both odontocetes and mysticetes appear in the fossil record five to seven million years ago, but the fossil record is poor. The relationship between early whales and modern baleen whales is unclear.
    - a. The modern genus *Balaenoptera* appeared about 5 to 10 million years ago.
    - b. The modern genus *Balaena* appeared about 5 million years ago.
    - c. The modern gray whale family, Eschrichtiidae, appeared 2 million years ago.

## **HABITAT AND DISTRIBUTION**

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- A. Distribution.
1. Baleen whales can be found in all oceans worldwide, from polar seas to temperate and tropical zones.
  2. Some species of baleen whales have limited distribution. For example –
    - a. Southern right whales (*Eubalaena australis*) are found only in the southern hemisphere; northern right whales (*Eubalaena glacialis*) are found only in the northern hemisphere.
    - b. Bowhead whales (*Balaena mysticetus*) inhabit the waters around the Arctic ice edges that melt and reform seasonally.
    - c. Some populations of baleen whale species are resident to restricted areas. A population of fin whales (*Balaenoptera physalus*) is found year-round in the Gulf of California.
  3. Some species are found throughout the world. For example, fin whales, minke whales (*Balaenoptera acutorostrata*), sei whales (*Balaenoptera borealis*), blue whales (*Balaenoptera musculus*), and

humpback whales (*Megaptera novaeangliae*) have worldwide distributions. Bryde's whales (*Balaenoptera edeni*) are found throughout the tropics and subtropics.

B. Habitat.

Some baleen whales are coastal. (They stay near shore.) They forage along the productive continental shelf area. Some species give birth and rear young in protected coastal bays and lagoons. Other species are oceanic. (They roam the open seas.)

C. Migration.

1. Most baleen whales are highly migratory, moving toward high-latitude (polar) feeding areas in the summer and toward low-latitude (tropical) calving areas in the winter.
  - a. Variations in water temperature, food availability, and feeding habits may account for movements of some animals.
  - b. Some individual whales do not migrate. These may be juveniles or post-reproductive adults and may stay in protected nearshore areas.
2. Northern and southern hemisphere populations of the same species don't encounter one another due to the opposite seasons in the northern and southern hemisphere. While the northern population is breeding and calving in tropical regions during the northern hemisphere's winter, the southern population is foraging in polar feeding grounds during the southern hemisphere's summer.
3. Many factors may act as environmental cues to help baleen whales navigate along a migration route: sun orientation, topography of the ocean floor, water temperature, chemical changes in the water, and magnetic sensing. Satellite-tracking studies assist scientists researching migratory behavior of baleen whales.
4. Most baleen whales migrate 3,000 to 5,000 km (1,800–3,000 miles) each way, depending on the species.
  - a. Gray whales migrate more than 10,000 km (6,000 miles) each way – the longest known migration for any mammal.
  - b. Some species migrate much shorter distances. For example, Bryde's whales only move from temperate regions to the equator. And sei whales don't migrate as far toward the poles as most species do.

D. Population.

1. For most baleen whale species, estimating abundance is difficult due to their vast distribution and their aquatic habits.

2. For many species, there are no population estimates. For others, estimates are based on old data that may no longer reflect the current population. The table below lists the most current estimates available.

**Family Balaenidae: the right whales**

bowhead whale <i>Balaena mysticetus</i>	Bering-Chukchi-Beaufort Seas	8,000
	Sea of Okhotsk	<i>probably 10s to a few 100s in each of these populations</i>
	Davis Strait	
	Hudson Bay	
	Greenland Sea	
pygmy right whale <i>Caperea marginata</i>	<i>(all in southern hemisphere)</i>	<i>unknown</i>
Southern right whale <i>Eubalaena australis</i>	southern hemisphere	4,300
Northern right whale <i>Eubalaena glacialis</i>	North Pacific	<i>possibly several hundred</i>
	North Atlantic	

**Family Balaenopteridae: the rorqual whales**

minke whale <i>Balaenoptera acutorostrata</i>	southern hemisphere	761,000
	North Atlantic	149,000
	western North Pacific	25,000
	rest of North Pacific	<i>unknown</i>
sei whale <i>Balaenoptera borealis</i>	southern hemisphere	37,000
	North Pacific	14,000
	North Atlantic	<i>probably few 1,000s</i>
Bryde's whale <i>Balaenoptera edeni</i>	western North Pacific	14,000
	rest of northern hemisphere	<i>unknown</i>
	southern hemisphere	<i>unknown</i>
blue whale <i>Balaenoptera musculus</i>	southern hemisphere	400–1,400
	California, Oregon, Washington	1,480
	rest of northern hemisphere	<i>unknown</i>
fin whale <i>Balaenoptera physalus</i>	North Atlantic	47,300
	southern hemisphere	103,000
	rest of northern hemisphere	<i>unknown</i>
	California, Oregon, Washington	3,200
humpback whale <i>Megaptera novaeangliae</i>	western North Atlantic	11,570
	rest of northern hemisphere	<i>unknown</i>
	southern hemisphere south of 60°S	10,000
	rest of southern hemisphere	<i>unknown</i>

**Family Eschrichtidae: the gray whale**

gray whale <i>Eschrichtius robustus</i>	eastern North Pacific	26,000
	western North Pacific	less than 100

2. As a management tool, scientists categorize a geographically isolated and genetically distinct group of whales as a whale *stock*. Thus, a species may be represented by several stocks. For some species, certain stocks are depleted, while worldwide population numbers remain high.
  - a. More than 800,000 minke whales are found worldwide, yet scientists consider the West Greenland stock depleted.
  - b. Most of the total current population of bowhead whales survives in only one of five stocks. The other four face extinction.
  - c. Certain stocks are recovering due to international protection from commercial whaling. Most notably, the gray whale population appears to have reached pre-whaling numbers.
  - d. Photo-identification of individual whales helps researchers monitor the size of certain populations. Experts photograph and catalog scars and other natural markings on the flukes, dorsal fins, and flanks of individual whales. When these identified whales are re-sighted during subsequent years, researchers can gather information on reproductive and growth rates, differences between males and females, and migration.

## **PHYSICAL CHARACTERISTICS**

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- A. Size.
  1. Baleen whales are some of the world's largest animals.
    - a. In the ocean, water helps support an animal's body weight, allowing for the potential for greater size than on land.
    - b. In general, females are about 5 percent longer than males of the same species.
    - c. Baleen whales of the northern hemisphere are usually slightly smaller than their counterparts in the southern hemisphere. And some whale stocks can be larger or smaller than other stocks of the same species. For example, sei whales reach 20 m (65 ft.) in the southern hemisphere, 18.6 m (61 ft.) in the North Pacific, and 17.3 m (57 ft.) in the North Atlantic.
  3. Large size has many adaptive advantages.
    - a. Large size decreases an animal's surface-to-body ratio, which helps a mammal retain body heat. See "Thermoregulation."

- b. In general, larger animals are safer from predators and are better able to compete for mates.
  - c. Large size allows whales to take advantage of seasonal high food productivity. They are able to eat enormous amounts at a time – more calories than they use – and store that energy in the form of blubber.
4. The largest whale – in fact, the largest animal, living or extinct – is the blue whale.
- a. Average length for Antarctic blue whales is about 25 m (82 ft.) for males and 27 m (89 ft.) for females. (Note: this average does not include measurements taken for a possible “pygmy” subspecies, *Balaenoptera musculus brevicauda*). Blue whales in the northern hemisphere are slightly smaller.
  - b. Record size for a blue whale – for a specimen taken during the whaling years – is 34 m (112 ft.). Another record-size individual weighed 190,000 kg (419,000 lb.).
5. Pygmy right whales are among the smallest baleen whales. Adult females reach lengths of 6.5 m (21 ft.), and adult males may reach 6.1 m (20 ft.). This species is rarely recorded, so details of its size are poorly documented.

B. Body shape.

The general body shape of baleen whales is roughly cylindrical but tapering at both ends. This characteristic fusiform shape is quite energy efficient for swimming. Compared to other body shapes, this body shape creates less drag (the opposing force an object generates as it travels through water).

C. Coloration.

1. Most baleen whales exhibit skin color variations of black and gray. Some are countershaded: a type of protective coloration in which the dorsal (top) surface is darker than the ventral (underneath) surface. When lighting is from above, the animal appears inconspicuous.
2. Blue whales are named for a steel blue-gray skin color.
3. Minke, humpback, bowhead, and fin whales are distinctively colored.
  - a. Northern hemisphere minke whales have a band of white across the otherwise black flippers. Individuals in the southern hemisphere may or may not have the flipper band.
  - b. Humpback whales are black or gray except for their flippers and the undersides of their flukes, which are white.

- c. Bowhead whales are dark gray to black except for a white chin.
    - d. A fin whale's head is asymmetrically colored. The right lower lip is white, and the rest of the head is black or gray. Fin whales also have a grayish white chevron-shaped mark on their backs.
  - 4. External parasites and algae growing on a whale's skin affect the coloration of some species.
    - a. Blue whales sometimes exhibit a yellowish ventral surface, a result of diatom growth. (Diatoms are one-celled algae.)
    - b. Barnacles and whale lice give a gray whale its characteristic mottled, light gray color.
  - 5. Some species, such as gray whales and sei whales, have white or faintly-colored marks or scars. Barnacle growth, shark or killer whale bites, and natural pigmentation differences can create these markings.
- D. Pectoral flippers.
  - 1. Pectoral flippers are a whale's forelimbs. They have all the skeletal elements of the forelimbs of terrestrial mammals, but they're foreshortened and modified into paddle-shaped appendages. The skeletal elements are rigidly supported by connective tissue: thick cartilage pads lie lengthwise between the bones.
  - 2. Pectoral flippers are an adaptation for swimming. Whales use their pectoral flippers mainly to steer and, with the help of the flukes, to stop.
  - 3. Rorquals and gray whales have four digits instead of five: the thumb bones are not present.
  - 4. Humpback whales have pectoral flippers that are as long as one-third their body length and are a contrasting white color.
- E. Flukes.
  - 1. The horizontal lobes of the tail of a whale are called flukes. (Each lobe is called a fluke.)
  - 2. Flukes are flattened pads of tough, fibrous connective tissue, completely without bone or muscle.
  - 3. Longitudinal muscles of the back and caudal peduncle move the flukes up and down.
- F. Hind limbs.

In baleen whales, the only traces of hind limbs are two reduced, rod-shaped pelvic bones. These non-functional bones are buried deep in body muscle, not connected to the vertebral column.

G. Dorsal fin.

1. Rorquals and the pygmy right whale have a fin on top called a dorsal fin. Like the flukes, the dorsal fin is made of dense, fibrous connective tissue, with no bones.
  - a. Dorsal fins are often scarred or marked. Photos of baleen whale dorsal fins can be used for photo-identification.
  - b. A humpback whale has a small dorsal fin on top of a hump. The shape varies among humpback whales.
  - c. Other rorquals have a backward-curving (falcate) dorsal fin, about two-thirds of the way toward the tail flukes.
  - d. Dorsal fins can be about 25 to 60 cm (1-2 ft.) tall, depending on the species.
2. Right, bowhead, and gray whales have no dorsal fin. Gray whales have a dorsal hump followed by a series of bumps.

H. Head.

1. Right whales have huge heads – one-fourth to one-third the body length.
  - a. In right whales, all seven neck vertebrae are fused, and right whales are incapable of side-to-side head movement.
  - b. A right whale's elongated upper jaw bones arch to house extremely long baleen. The lower jaw line is sharply upward-curved in profile.
  - c. Encrusting, yellow-white growths on the head, jaws, and blowhole areas of right whales are called callosities. Accumulations of natural markings such as these aid researchers in photo-identification studies.
2. A rorqual has a broad, flat rostrum and a slightly curved jaw line. Un-fused neck vertebrae allow for some flexibility at the head and neck. Some species have ridges on the rostrum and a V- or U-shape to the tip of the snout. A humpback whale has several knobs on its head.
3. A gray whale has a narrow head with a slight curve to the jaw line. Un-fused neck vertebrae allow for some flexibility at the head and neck.
4. Blowhole.
  - a. In whales, the nasal openings (nostrils) are at the top of the head.

- b. The nasal opening of a whale is called a blowhole. Baleen whales have two blowholes.
- c. Just as our nostrils lead to an air passage that leads to our trachea and then our lungs, a baleen whale's blowholes lead to an air passage that leads to its trachea and then its lungs.
- d. Each blowhole is covered by a muscular flap. In a relaxed position, the muscular flap provides a water-tight seal.

I. Baleen.

1. In the mouth of a baleen whale, stiff plates of keratin grow down from the gums of the upper jaw. These plates are called baleen. They grow in rows on each side of the mouth.
  - a. Keratin is a fibrous protein that also composes hair and fingernails. It is strong yet somewhat elastic. Like our hair and fingernails, it grows throughout a whale's lifetime, and the ends continually wear off.
  - b. Baleen plates range in color from black to yellow or white, depending on the species.
  - c. The outer edge of each plate is smooth. The inner edge is frayed. The frayed inner edges of the plates intertwine to form a mat.
  - d. Baleen plates arise in a whale fetus as thickenings of skin on the upper jaw.
2. Right whales have the longest baleen. Bowhead whales are particularly known for their long baleen plates, which reach lengths of 4 m (13 ft.). Bowhead whales typically have 230 to 360 baleen plates on each side of the upper jaw.
3. Gray whales have about 130 to 180 baleen plates on each side of the upper jaw. Each plate is about 5 to 25 cm (2-10 in.) long.
4. In the rorqual family, baleen size ranges from the blue whale's 91-cm (3-ft.) baleen plates to the minke whale's 12- to 20-cm (5- to 8-in.) baleen plates. Blue whales typically have 260 to 400 baleen plates on each side of the upper jaw. Minke whales have about 230 to 360 on each side.
5. Baleen is an adaptation for filter-feeding.
6. Parasitic copepods, nematodes, and protozoans can infest a whale's baleen plates.
7. Baleen whales do not have teeth. They do develop tooth buds during the embryonic stage, but these tooth buds disappear before birth.

8. Although baleen is not bone tissue, it is sometimes referred to as “whalebone.” Baleen whales have also been known as “whalebone whales.”

J. Skin.

1. Baleen whales have smooth skin, without oil glands or pores. The epidermis is about 5 to 7 mm (0.2–0.3 in.) thick.
2. Many species have sparse hairs on the snout, jaws, and chin.
3. A whale’s lack of fur is an adaptation for more efficient swimming: fur or hair creates drag as an animal swims.
4. A variety of parasites can infest a baleen whale’s skin.
  - a. Diatoms grow on the skin of some species, including the blue whale. The diatom layer creates an olive-colored film on the skin.
  - b. Gray and humpback whales are heavily infested with external parasites. Barnacles and whale “lice” (actually amphipods) attach to skin around the head, blowhole, genital area, and throat grooves. Barnacles feed on plankton in the water. Whale lice feed on whale skin and damaged tissue such as a wound.

K. Throat grooves.

1. Rorqual, gray and pygmy right whales have grooves under the throat that extend to at least the pectoral flippers.
  - a. Members of the rorqual family have between 25 and 100 throat grooves, depending on the species.
  - b. A gray whale has between two and seven throat grooves.
  - c. A pygmy right whale has just two throat grooves
  - d. Right whales do not have throat grooves.
2. Throat grooves are folds of skin and blubber that expand during feeding, greatly increasing the volume that the whale’s mouth can hold. The throat grooves fold back into a streamlined shape when a whale isn’t feeding.

## **SENSES**

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A. Hearing.

1. Baleen whales probably have well-developed hearing, which is valuable in the poorly lit ocean, where vision is less helpful.
2. A whale’s ears are adapted for hearing underwater, not in air.

- a. The middle and inner ears of cetaceans follow a basic mammalian ear structure.
  - b. A baleen whale has a small external ear opening on each side of the head. Each ear opening leads to a narrow auditory canal that is completely plugged by a waxy substance.
  - c. Both bone and soft tissue are probably important in conducting sound to the ears.
3. The anatomy of the baleen whale ear is somewhat typical of an ear adapted to hear low-frequency sounds.
- B. Eyesight.
1. The lens of a marine mammal's eye is stronger than that of a land mammal.
    - a. In the eye of a land mammal, the cornea focuses light rays toward the lens, which further focuses the light rays onto the retina. Underwater, the cornea isn't able to adequately focus waves into the lens because the refractive index of water is similar to that of the interior of the eye.
    - b. The eye of a marine mammal compensates for this lack of refraction at the cornea interface by having a much stronger, spherical lens. It is more similar to the lens of a fish's eye than the lens of a land mammal's eye.
    - c. In air, a marine mammal's eye compensates for the added refraction at the air-cornea interface. At least in bright light, constricting the pupil helps, but it doesn't fully explain how a whale achieves visual acuity in air. Research is ongoing.
  2. The retina of a baleen whale's eyes contains mostly "rod cells," which are sensitive to low intensity light. "Cone cells," which distinguish between different colors and are most sensitive to bright light, are less abundant.
  3. The tapetum lucidum is a reflective layer behind the retina. It reflects light back through the retina a second time, making the most of available light under low light conditions.
  4. A whale's eyes are constantly bathed in water. There are no tear ducts, but glands at the outer cornea and eyelids secrete an oily substance that lubricates and cleans the eyes.
- C. Tactile.
1. The tactile sense has not been well studied in baleen whales, and the sensitivity of their skin is largely unknown.

2. Gray whales in certain breeding lagoons in Baja California, Mexico seem to seek out people and solicit interaction including touch. So far we do not have an accurate interpretation of this behavior.

D. Taste.

The sense of taste has not been well studied in baleen whales, and whether they have any sort of taste reception is unknown.

E. Smell.

Olfactory nerves and bulbs are present in baleen whales during the fetal stage, but they are greatly reduced in the adult brain. The sense of smell has not been well studied in baleen whales, and whether they have any sort of ability to smell is unknown.

## **ADAPTATIONS FOR AN AQUATIC ENVIRONMENT**

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A. Swimming.

1. A baleen whale swims with up-and-down strokes of its powerful tail flukes. Muscles in the upper and lower regions of the caudal peduncle (tail stalk) provide power.
2. Rorquals are more streamlined than other baleen whale families, and they swim fastest of baleen whales. The fastest can reach probably approach speeds of 32 kph (20 mph).
3. Other species travel at slower speeds. Gray whales migrate at about 10 to 11 kph (6-7 mph).
4. The thick layer of blubber under the skin of a whale results in a streamlined, fusiform body, making a whale energy-efficient for swimming.

B. Diving.

1. Many species of baleen whales feed in relatively shallow areas of the continental shelf. Most are not known for diving regularly to great depths.
  - a. Gray whales make shallow dives of 15 to 50 m (50-165 ft.), but may dive for food as deep as 120 m (390 ft.) in polar feeding grounds.
  - b. Humpback whales dive to at least 148 m (485 ft), and fin whales dive to a maximum of about 355 m (1,165 ft.).
2. All marine mammals have special physiological adaptations during a dive. These adaptations enable a baleen whale to conserve oxygen while underwater.

- a. Baleen whales, like other mammals, have a slower heart rate while diving.
- b. When diving, blood is shunted away from tissues tolerant of low oxygen levels toward the heart, lungs, and brain, where oxygen is needed most.
- c. Certain protein molecules—hemoglobin and myoglobin—store oxygen in body tissues. Hemoglobin occurs in red blood cells. Myoglobin occurs in muscle tissue. The muscle of baleen whales has twice the myoglobin concentration of the muscle of land mammals.

C. Respiration.

1. Baleen whales breathe through two blowholes on top of the head. A baleen whale holds its breath under water and surfaces to breathe.
  - a. As it surfaces, the whale opens its blowholes and explosively exhales.
  - b. After exhaling, the whale quickly inhales, then closes the blowholes before diving.
  - c. For a gray whale, each exhalation/inhalation takes about two seconds.
2. Baleen whales typically breathe several times at the surface before submerging again for several minutes. The number of respirations depends on the whale's activity level. For example, right whales often stay under water for 5 to 15 minutes, then surface and blow five to ten times at 3- to 15-second intervals before diving again.
3. The visible spout of water that rises from a baleen whale's blowhole is not coming from the lungs, which (like ours) do not tolerate water.
  - a. Water that is on top of the blowhole when the powerful exhale begins is forced up with the exhaled respiratory gases.
  - b. Especially in cool air, a mist may form; it is water vapor condensing as the respiratory gases expand in the open air.
4. Many baleen whale species can often be identified by the size and shape of the "blow."
  - a. Right whales have a low, bushy blow.
  - b. A blue whale's blow may reach 9 m (30 ft.) in the air.
  - c. A gray whale's blow looks heart-shaped when viewed from directly behind or in front of the whale.
  - d. Minke whales sometimes have no visible blow.

## D. Thermoregulation.

1. Like all mammals, whales are warm-blooded. A baleen whale's core body temperature is about 36.6° to 37.2° C (98–99° F) – about the same as that of a human. Living in the sea poses a particular challenge to marine mammals, because heat loss occurs about 27 times faster in water than in air at the same temperature.
2. The large size of a baleen whale helps minimize heat loss.
  - a. In general, as an animal increases in size, its surface area decreases relative to volume. A whale's fusiform body shape and reduced limb size further decrease this surface-to-volume ratio.
  - b. A low surface-to-volume ratio helps an animal retain body heat: the large body core produces metabolic heat. Only through the relatively smaller surface area exposed to the external environment (the skin) is that heat lost.
3. A thick layer of blubber just under a whale's skin helps insulate a whale from heat loss. There is a heat gradient from the body core, through the blubber, to the skin.
  - a. Blubber tissue is composed of fat cells and fibrous connective tissue.
  - b. The blubber layer can reach a thickness of 50 cm (20 in.) on a bowhead whale.
4. A baleen whale's circulatory system adjusts to conserve or dissipate body heat and maintain body temperature.
  - a. Some arteries of the flippers, flukes, and dorsal fin are surrounded by veins. Thus, some heat from the blood traveling through arteries is transferred to venous blood rather than the environment. This phenomenon is called countercurrent heat exchange.
  - b. When a baleen whale dives, circulation decreases at the skin, shunting blood to the insulated body core.
  - c. During prolonged exercise or in warm water a whale may need to dissipate body heat. In this case, circulation increases near the surface of the flippers, flukes, and dorsal fin. Excess heat is shed to the external environment.

## BEHAVIOR

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### A. Behavior observation.

For the most part, whales are visible only when at the surface breathing—less than 20% of the time—so it is inherently challenging to document and study whale behavior.

### B. Social behavior.

1. Baleen whales are generally found singly or in loose associations, not in large groups or families. Exceptions include migrating baleen whales, which may be found in small groups of several individuals, and large numbers of individuals that may congregate in feeding or calving areas.
2. All species of baleen whales establish strong mother/calf bonds. In fact, the strongest apparent bond between two individuals is between a calf and its mother.
  - a. Mother and calf stay in close physical contact throughout the nursing period. A mother baleen whale stays close to her calf and attentively directs its movements. The baby swims close to its mother and is carried in the mother's "slip stream," a type of hydrodynamic wake that develops as the mother swims.
  - b. A mother whale may teach her calf certain behaviors.
  - c. Whalers noted that female whales became aggressive when protecting their young.

### C. Individual behaviors.

1. Research into baleen whale behavior is ongoing. Some behaviors may be interpreted as being related to food-gathering, aggression, excitement, warning, visual inspection, or mating.
  - a. Some baleen whales slap their pectoral flippers, tail flukes, or head on the surface of the water, which creates loud sounds under water.
  - b. Calves and adults have been seen pushing around objects such as logs, kelp, and debris.
2. Whale watchers and researchers have named certain common whale behaviors.
  - a. A breach is a behavior in which a whale powerfully thrusts a large part of its body out of the water and lands on the surface—usually on its side or on its back—with a huge splash. Sometimes the same whale will breach several times in sequence.

- b. A spyhop is a behavior in which a whale rises out of the water somewhat vertically, exposing its head.
  3. Various baleen whale species show characteristic behaviors.
    - a. Gray, fin, minke, bowhead, and right whales commonly breach and spyhop.
    - b. Bowhead and right whales exhibit head- and body-slapping.
    - c. Humpback whales may be the most acrobatic species of baleen whales. They breach, spyhop, charge other whales, stroke other whales' flippers and flukes, and slap their flippers and tail flukes on the water's surface.

## **DIET AND EATING HABITS**

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- A. Food preferences and resources.
  1. In general, baleen whales feed low on the food chain, primarily eating zooplankton and small fishes, which they encounter in large swarms or schools.
  2. Right whales eat zooplankton (animal plankton). Their finely fringed baleen is able to strain from the water copepods (a type of small crustacean) and other small zooplankton. Krill (a family of small, shrimplike crustaceans) and copepods are major components of a right whale's diet.
  3. Rorquals generally eat larger prey than do right whales. Depending on species, they eat a variety small crustaceans, squids, and small schooling fishes.
    - a. Blue whales eat mostly krill.
    - b. Fin whales eat krill, copepods, squids, and variety of small schooling fishes.
    - c. Humpback whales, Bryde's whales, and minke whales prey mostly on krill and small schooling fishes. Minke whales in the northern hemisphere prey mostly on small schooling fishes; those in the southern hemisphere prey mostly on krill.
    - d. Sei whales eat copepods, krill and amphipods (another type of small crustacean). In the North Pacific and North Atlantic Oceans they also eat squids and small schooling fishes.
  4. Gray whales eat mainly invertebrates that live in bottom sediments, mostly amphipods and probably marine worms.

5. It's likely that some whales' diets depend on food availability.
- B. Food intake.
1. Most baleen whales spend about four to six months in the summer feeding intensively in high-latitude, productive waters. They spend the next six to eight months traveling and breeding.
  2. Scientists estimate that large baleen whales eat about 4% of their body weight each day during the feeding season. Food intake during the feeding season exceeds daily requirements, and excess energy is stored as fat, much of it in the blubber.
    - a. A blue whale eats up to 3,600 kg (8,000 lb.) of krill each day for about 120 days. It is estimated to take 1,000 kg (2,200 lb.) of food to fill a blue whale's stomach.
    - b. Gray whales eat about 150,000 kg (340,000 lb) of food during a 130- to 140- day feeding period – a daily average intake of about 1,089 kg (2,400 lb.). It is estimated to take 300 kg (660 lb.) of food to fill a gray whale's stomach.
    - c. Gray whales gain about 16% to 30% of their total body weight during a feeding season.
  3. Throughout the traveling and breeding season, baleen whales eat much less or not at all. Blubber gained during the feeding season sustains the whale during the winter months.
    - a. A baleen whale's thick blubber layer stores fat; it is an energy reserve that is necessary during the traveling and breeding seasons.
    - b. Winter daily feeding rate is only about 0.4% of body weight.
    - c. Blubber makes up 27% of a blue whale's body weight, 23% of a fin whale, 21% of a sei whale, 29% of a gray whale, and 36% to 45% of a right whale.
- C. Method of collecting and eating food.
1. A right whale "grazes" by swimming slowly through swarms of small zooplankton (animal plankton) with its mouth open. At the surface this has been termed "skim-feeding," but right whales also feed under water.
    - a. Water – and zooplankton – enter a right whale's mouth through a gap in the front baleen plates. Zooplankton is caught in the finely fringed baleen mat; water flows through the baleen and out the sides of the mouth.

- b. With long baleen plates and a huge mouth, right whales are adapted for straining immense amounts of food.
    - c. Right whales usually feed singly, but a group of whales may swim and feed in a V-formation.
  2. Rorqual whales feed by gulping enormous mouthfuls of prey and water. As its mouth fills, a rorqual's throat grooves expand and its mouth cavity balloons outward. Then the whale brings its jaws together and contracts the throat grooves, forcing water out.
    - a. Prey such as krill and small fishes are caught in the baleen mat as water is forced through the baleen and out the sides of the mouth.
    - b. Rorquals may feed at the surface or deeper in the water.
    - c. Humpback whales have been observed blowing "bubble nets" to help them feed. The whale dives down, then swims up in a spiral while releasing bubbles of air from its blowholes. The bubbles float up in a column, keeping prey inside the column. The whale lunges up through the center of the column with its mouth open. Observers have seen several humpback whales lunge-feeding up through a "bubble net," one at a time.
    - d. Some rorquals have been observed sweeping or flicking prey swarms with their the tail flukes toward mouth area.
    - e. Sei whales have also been observed skim-feeding as right whales do.
  3. Gray whales feed mostly along the ocean bottom. A gray whale rolls on its side and sucks in water, mud, and bottom-dwelling invertebrates, which are abundant in ocean sediments.
    - a. Prey such as amphipods and marine worms is caught in a gray whale's short, coarse baleen mat. Water and mud flow through the baleen and back out.
    - b. Scientists have observed large excavated areas on the ocean bottom in gray whale feeding grounds and have also observed surfacing gray whales trailing streams of mud.
    - c. Curiously, most gray whales appear to be "right-handed." They roll onto the right side when feeding. Others favor the left side. This is apparent by examining gray whale baleen, which is shorter and shows more wear on one side than the other.
    - c. During migration, gray whales may occasionally feed in the water column on swimming prey.

4. A baleen whale probably uses its huge tongue for moving food trapped inside the baleen, for squeezing water out of the mouth, and for swallowing.

## **REPRODUCTION**

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- A. Sexual maturity.
  1. Estimates of sexual maturity in baleen whales range from about 4 to 11 years, depending on the species. This information is not known for all species.
  2. Sexual maturity is often reported as length. For example, Bryde's whales are sexually mature at about 12 m (39 ft.), minke whales at about 7 to 8 m. (23–26 ft.)
- B. Reproductive seasons.
  1. Mating and birth seasons are linked to the annual migration cycle. While there is much variation, many whales mate in low-latitude (tropical) calving areas during the winter.
  2. Female baleen whales probably come into estrus (the period of sexual receptivity) once a year, but if conception fails to occur, they may come into estrus a second time.
  3. Male display a seasonal reproductive cycle which correlates with a winter estrus in females.
- C. Mating activity.
  1. In right, bowhead, and gray whales, breeding behavior often includes several males and one female. These breeding groups may interact for more than an hour before mating. The female may allow the largest and most aggressive male to mate with her, or she may flee or roll away. A female may mate with more than one male during a single breeding season.
  2. Right whales and rorqual whales engage in aggressive breeding activity that includes males fighting with each other to gain access to a female. Battles result in males ramming and sometimes wounding each other. Females may mate with just one winning male.
  3. Male humpback whales are famous for their "songs," which have been noted only in winter mating grounds. Whether or not these songs play a role in mating activity is not known.

D. Gestation.

1. Gestation period for baleen whales ranges from about 10 to almost 14 months, depending on the species.
2. A pregnant female's energy needs greatly increase during the second half of the gestation period. Also, a pregnant female stores energy that she will need to lactate (produce milk) after her calf is born. In some species, pregnant females in their last six months of pregnancy eat as much as 50% to 60% more than non-pregnant females.
3. Newly pregnant females are usually first to leave the breeding grounds and head for summer feeding grounds. They are usually last to leave feeding areas in the fall.

E. Calving and birth.

1. Most species of baleen whales give birth seasonally – primarily during the winter, as they approach warm-water, low-latitude breeding grounds or after they arrive. In the warmer-water breeding grounds, a newborn whale uses far less energy for keeping warm than it would in polar seas. (It quickly develops the insulating blubber layer that will help it maintain body temperature when it migrates toward colder seas in the spring.)
2. Baleen whales give birth to a single calf. In most species, a female may bear a calf every two to four years. If twins are conceived, they are unlikely to survive to full term. In rare cases where twins are born, they are not likely to survive due to the limited milk supply from the mother.
3. Observations of baleen whale births are extremely rare.
  1. Some species seek protected coastal areas to give birth.
  2. Tail-first deliveries have most often been observed, and a few head-first deliveries have also been documented.

F. Calf at birth.

1. Whale calves can swim at birth.
2. In general, a calf is approximately a quarter of the mother's length. A calf's birth weight is about 3% to 4% of its mother's weight.
  - a. The smallest baleen whale calves – at about 1.5 m (5 ft.) – are newborn pygmy right whales.
  - b. Newborn blue whale calves are about 7 m (23 ft.) long and weigh about 2,700 to 3,600 kg (6,000–8,000 lb.).
3. Baleen whale calves have small, soft baleen plates that soon stiffen.

## G. Nursing.

1. A whale calf suckles from nipples concealed in its mother's abdominal mammary slits. Calves nurse under water.
2. A baleen whale calf nurses for 4 to 11 months. By its first summer in feeding grounds, it is weaned.
3. The high fat content (up to 40% to 50% fat) of whale milk allows the calf to rapidly develop a thick insulating layer of blubber.

## H. Calf growth.

1. In general, whale calves gain weight quickly, although growth rate varies by species. For example, nursing blue whale calves gain 90 kg (200 lb.) each day. Gray whale calves double their weight in about three months and double their length in about two years.
2. Sei whales are 4.5 m (15 ft.) at birth and grow about 2.5 cm (1 in.) each day. Nursing humpback whale calves grow 45 cm (1.5 ft.) per month.

## **COMMUNICATION**

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## A. Sound production.

1. Baleen whales produce primarily low-frequency sounds—mostly well below 5,000 Hz.
  - a. Such sounds may be the loudest produced by any animal and may travel for hundreds of kilometers under water.
  - b. Researchers speculate that these loud sounds may be for long-range contact, assembly, advertisement for mates, greeting, location, orientation, threat, navigation, or individual identification. Research is ongoing.
2. Specific vocalizations vary by species.
  - a. The repertoire of baleen whale sounds includes very low-frequency (20–200 Hz) moans, grunts, thumps and knocks; and higher-frequency (above 1000 Hz) chirps, cries, whistles, and songs.
  - b. Humpback whales also produce a series of repeating units of sounds (up to 8,000 Hz) that are classified as “songs.”
    - (1) Songs are produced by males, and only while in breeding grounds.
    - (2) More analysis is needed before the function of whale songs is understood, and any adaptive advantages of singing are as yet unknown. Experts speculate that such vocalizations may keep

males spaced apart; attract females; make it possible for whales to locate each other; or communicate information such as species, sex, location, mate status, and readiness to compete with other males for mates. There have been no conclusions.

3. The location of sound production is unknown but the larynx is suspected. Baleen whales have no vocal cords.

B. Body language.

Whales produce some sounds via body displays. Such sounds may be involved with communication. Noises such as forceful spouts may signal aggravation. Slapping pectoral flippers or flukes may indicate arousal, excitement, or aggression.

C. Echolocation.

There is no evidence that baleen whales echolocate the way toothed whales do. Studies have shown, however, that bowhead whales produce low-frequency sounds that may give the whales information about the ocean floor and locations of ice.

## **LONGEVITY AND CAUSES OF DEATH**

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A. Longevity.

Longevity for most baleen whales is unknown. Some researchers have estimated that blue whales may live 30 to 90 years, fin whales may live 90 to 100 years, and sei whales may live as long as 60 years.

B. Aging studies.

1. Research on baleen whale aging is ongoing. The absence of teeth (which can be used to approximate age in toothed whales and many other mammals) makes age estimation difficult.
2. Researchers are analyzing growth patterns on baleen plates and on the waxy ear plug of baleen whales in an effort to find a reliable method for estimating age.

C. Predators.

1. Killer whales prey on baleen whales. Working together, a group of killer whales can successfully attack a baleen whale much larger than themselves.
  - a. A 1985 study in one particular region near the Antarctic suggests that minke whales make up 85% of the killer whales' diet there.

- b. Teeth scars on some baleen whales' flippers and flukes are evidence of killer whale attacks.
  - 2. Large sharks may prey on some baleen whales, particularly those that are ill, injured, or very young.
  - 3. The small (38 cm, or 15-in.) cookiecutter sharks use suction to attach themselves to whales, then they carve out a circular core of flesh with their large triangular teeth.
- D. Commercial whaling.
- 1. The commercial whaling industry began to expand in the 12th century.
    - a. Whale oil was used for lighting, heating, and lubrication; as a base for the manufacture of soaps and paints; and in processing textiles and rope.
    - b. Baleen was used to make corset stays, umbrella ribs, fishing rods, buggy whips, carriage springs, skirt hoops, brushes, and nets.
  - 2. Early whaling efforts focused on species of the right whale family.
    - a. The right whale family was so named because whalers considered these whales the "right" whales to harvest. Whales in this family were best for harvesting because have immense amounts of blubber and long baleen; they are slow swimmers; they are coastal species; and their bodies float when dead.
    - b. As the right whales became overhunted, the whaling industry sought out more numerous species to harvest.
  - 3. Whaling methods and equipment improved in the 19th and 20th centuries.
    - a. Improved weapons and boats made it possible for whalers to hunt faster species such as humpback, blue and fin whales.
    - b. Modern harpoons, explosives, and factory-type processing ships made whaling more efficient and resulting in greater numbers of whales killed.
    - c. Demand for whale oil and baleen decreased because alternatives were available, but demand for whale meat increased.
    - d. By the 1960s, blue whales were nearly extinct, and fin whales had also been overhunted. Whalers turned their attention to sei whales. When sei whales became severely depleted in the 1970s, minke and Bryde's whales became target species. All the larger species had become depleted due to overhunting.

- e. For the most part, commercial whaling ended by the 1980s, but most whale populations have yet to recover.
- E. Indigenous and small-scale whaling.

Indigenous peoples from various coastal areas hunt some species of baleen whales for subsistence. For instance, people in coastal arctic villages hunt small numbers of bowhead whales, minke whales, and gray whales.
- F. Environmental hazards.
  - 1. Baleen whales may be harmed by entanglement in fishing gear, heavy boat traffic, pollution, and competition with humans for food resources.
  - 2. Baleen whales in polar areas may become entrapped in ice.
- G. Disease.

As in any animal population, a variety of diseases can be responsible for baleen whale deaths.

## **CONSERVATION**

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- A. The International Whaling Commission (IWC).
  - 1. In 1946, 14 countries signed the International Whaling Convention for the regulation of whaling, forming the International Whaling Commission (IWC). The goal of the IWC is to manage whale stocks as a resource.
  - 2. The IWC monitors whale populations through scientific advisory groups and coordinates and funds a variety of whale research.
  - 3. In 1986, the IWC declared a moratorium on commercial whaling. The moratorium – which is still in effect – allows for the possibility of regulated commercial whaling in the future.
    - a. The IWC continues to develop its “Revised Management Procedure,” which would ultimately set safe catch limits for certain whale stocks where the numbers are deemed plentiful. The plan sets limits on the species, numbers and size of whales which may be taken; and prescribes open and closed seasons and areas for whaling. It also requires observation, reporting, and data gathering.
    - b. At times various nations threaten to ignore the IWC recommendations and resume whaling. In fact, since the moratorium has been in effect, hundreds of baleen whales (mostly minke whales) have been killed commercially “under objection” by the IWC. The IWC has no means by which to enforce regulations.

B. IUCN/The World Conservation Union.

IUCN/The World Conservation Union is a worldwide conservation organization. This organization links together government agencies, non-government agencies, and independent states to encourage a worldwide approach to conservation.

C. Legal protection for baleen whales.

1. The U.S. Marine Mammal Protection Act (MMPA) of 1972 made it illegal to hunt or harass marine mammals in the U.S.
  - a. The primary objective of the MMPA is to maintain the health and stability of the marine ecosystem and to obtain and maintain an optimum sustainable population of marine mammals.
  - b. According to the MMPA, all whales in U.S. waters (baleen and toothed) are under the jurisdiction of the National Oceanic and Atmospheric Administration (NOAA).
  - c. The MMPA does allow for certain exceptions: native subsistence hunting; taking marine mammals for research, education, and public display; and taking restricted numbers of marine mammals incidentally in the course of fishing operations.
2. Six species of baleen whales are listed for protection under the United States Endangered Species Act of 1983: the blue, bowhead, fin, humpback, right, and sei whales.
  - a. The primary reason for their endangerment is overhunting during the years of commercial whaling.
  - b. The eastern Pacific gray whale population was removed from the Endangered Species List in 1993 because it seems to have reached pre-whaling numbers (about 26,000 whales in 1998).
3. The Convention in International Trade of Endangered Species (CITES) is an international treaty developed in 1973 to regulate trade in certain wildlife species. All species of baleen whales are listed under CITES Appendix I, the most endangered of CITES-listed animals and plants. CITES prohibits commercial international trade in specimens of Appendix I species.

D. Whale watching.

1. Whale watching expeditions bring people close to wild whales and help people learn about them.
2. The NOAA has developed “Marine wildlife viewing guidelines” to protect marine animals. Among other recommendations, the guidelines instruct whale watchers to keep their distance. Chasing or

harassing animals, impeding their right of way, touch and feeding animals are not allowed.

- E. Baleen whales in zoological environments.
1. Baleen whales are not commonly displayed in zoological environments. In general, their size, their diet and feeding habits, and their endangered status make them poor candidates for public display.
  2. SeaWorld parks have rescued some stranded baleen whales, including gray whales, minke whales, and a Bryde's whale. Some of these rescued whales did not survive, while others were successfully rehabilitated and released.
    - a. In 1988, SeaWorld of California assisted and freed three California gray whales that had become entangled in drift nets.
    - b. In 1989, SeaWorld of Florida rescued a 2,270-kg (5,000-lb.) Bryde's whale stranded on a Florida beach. After six weeks of treatment and round-the-clock care, the whale was successfully released back into the ocean.
    - c. In 1997, SeaWorld of California rescued and rehabilitated an orphaned gray whale calf that stranded in Southern California. After 15 months of care, the whale was returned to the sea.
    - d. Stranded animals are a valuable scientific resource. Insight gained from caring for rescued whales adds to the growing body of knowledge that helps us to care for cetaceans and to better understand cetacean biology.