Scientific Classification

Killer Whales

Scientific Classification

Class - Mammalia

1. Mammals are characterized by the following features:
   Mammals breathe air with lungs.
   Mammals are "warm-blooded": they maintain a constant, high body temperature independent of their surroundings.
   As a rule, mammals bear live young. (Two primitive mammals are exceptions to this rule: the duckbilled platypus and the spiny anteater/echidna both lay eggs.)
   Mammals nurse their young with milk.
   Mammals have hair, at least at some stage in their development. A whale's smooth skin is an adaptation for swimming. A newborn calf often has a few sparse hairs around the rostrum that are lost within the first days of life.

Order - Cetacea

1. Cetacea is a scientific order of large aquatic mammals that have forelimbs modified into flippers, a horizontally flattened tail, one or two nostrils 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, κῆτος.
3. Biochemical and genetic studies suggest that even-toed ungulates, especially hippopotamuses (Family Hippopotamidae), are cetaceans' closest living terrestrial relatives. (Sheep, cows, pigs, and giraffes are also examples of even-toed ungulates.) These animals and whales probably share a common ancestor.
4. Recently, some scientists suggest that since cetaceans genetically and morphologically fall within the artiodactyl clade, they should be included in the Order Cetartiodactyla with Cetacea as an unranked taxon.
5. Living cetaceans are further divided into two suborders: the Odontoceti (toothed whales) and the Mysticeti (baleen whales.)

Odontoceti
killer whale, Orcinus orca

Mysticeti
gray whale, Eschrichtius robustus
Suborder - Odontoceti

1. Odontoceti is a scientific suborder of whales characterized by having teeth and a single blowhole. The word “Odontoceti” comes from the Greek word for tooth, *odontos*.

Family - Delphinidae

1. Dolphins and their immediate kin are included in the scientific family Delphinidae. This family is represented by about 36 species, including bottlenose dolphins, pilot whales, and false killer whales. The killer whale is the largest member of the dolphin family.

Genus Species - Orcinus Orca

1. The Latin name *Orcinus* translates as "belonging to Orcus," Orcus was a Roman god of the netherworld, and this genus name is likely a reference to the ferocious reputation of the killer whale. In Latin, *orca* translates "large-bellied pot or jar," but *orc-* also refers to a whale.
1. Killer whales gained their common name because some types prey on other whales. They were once called “whale killers” by sailors who witnessed their attacks on larger cetaceans. Over time, the name was gradually switched to “killer whale”.

2. Another common name for killer whales in Spanish is ballena asesina, which translates to “assassin whale.” The German common name is schwertwal, or “sword whale”—a reference to their large dorsal fin. Native Americans call them by names including klasqo’kapix (Makah, Olympic Peninsula), ka-kow-wud (Quillayute, Olympic Peninsula), max’inux (Kwak’utl, northern Vancouver Island), qaqwun (Nootka, western Vancouver Island), and ska-ana (Haida, Queen Charlotte Islands). Other common names include blackfish and orca.

Killer Whale ecotypes (forms)

1. Scientists currently recognize at least ten killer whale ecotypes throughout the world’s oceans. These ecotypes have overlapping geographic ranges in certain areas but have slight genetic differences and distinct differences in size, habitat, color pattern, dorsal fin shape, vocalizations, diet, and hunting strategies.

   In the Northern Hemisphere, at least five forms are recognized: resident, transient, and offshore killer whales in the Pacific, and eastern North Atlantic types 1 and 2.

   Ecotypes in the Southern Hemisphere include Antarctic type A, large type B, small type B, type C and D type.

   All of these ecotypes are currently considered a single species, but many scientists feel that a taxonomic update is needed.

2. In the eastern North Pacific Ocean, observers have recognized that various groups of killer whales show physical and behavioral differences. They categorize pods of eastern North Pacific killer whales into three ecotypes: “transient,” “resident,” and “offshore.”
Researchers analyzed samples collected from 73 whales in the eastern North Pacific and found significant genetic differences among transient whales and two separate groups of resident whales.

The offshore ecotype has been identified but not as well studied as the resident and transient ecotypes. It appears to be more closely related to the resident ecotype than to the transient ecotype.

3. A fourth potential killer whale ecotype in the Pacific inhabits the Eastern Tropical Pacific (ETP).

4. Researchers have identified five forms of killer whales in Antarctic waters. They categorize the Antarctic killer whales as "type A", "small type B", "large type B", "type C", or "type D".

5. Type 1 and type 2 killer whales inhabit the North Atlantic.


Fossil Record

1. Early whales evolved over 50 million years ago from mammals that returned to the sea.

2. While the fossil record is poor in regard to modern cetaceans, most modern forms of both odontocetes and mysticetes appear in the fossil record five to seven million years ago. Recent mitochondrial and nuclear DNA analyses support the theory that cetaceans are distant cousins of even-toed ungulates (artiodactyla) and that hippopotamids are the closest living relative to cetaceans.

3. The remains of one such ancient hippopotamid discovered in Kashmir, India—Indohyus—is placed in the extinct family Raoellidae. It’s theorized that Indohyus took to the water as a means of escaping predators, as opposed to finding new food sources, some 48 million years ago. The middle ear space of Indohyus features a thick bone covering called an involucrum—previously, the only other animals known to have an involucrum have been cetaceans.

4. In Italy, experts have uncovered Pliocene (two to five million years old) fossils that seem to be related to modern killer whales. The fossil skull of a whale that has been named Orcinus citoniensis had smaller teeth—and more of them—than modern killer whales. Scientists have identified large, fossil delphinid teeth, mostly from the Pliocene, as those of an Orcinus species.
Habitat & Distribution

Habitat/Distribution

1. Killer whales inhabit all oceans of the world. Next to humans, killer whales are the most widely distributed mammal.

2. In search of prey, killer whales are not limited by water depth, temperature, or salinity.

3. Populations have been documented foraging for long periods of time in shallow coastal and inter-tidal flats in just a few meters of water.

4. While killer whales can be found around the world, they are much more common in highly productive areas of cold-water upwelling; including the Pacific Northwest, along northern Norway’s coast in the Atlantic, and the higher latitudes of the Southern Ocean.

   Killer whales are most numerous in the Arctic, Antarctic and areas of cold water upwellings where food is plentiful.

5. In addition to being found in colder water, killer whales also have been seen in warm water areas such as Florida, Hawaii, Australia, the Galapagos Islands, the Bahamas, and the Gulf of Mexico and more temperate waters such as New Zealand and South Africa. Such sightings are infrequent, but they do demonstrate the killer whales’ ability to venture into tropical waters.

6. Rarely, killer whales have been seen in fresh water rivers around the world such as the Rhine, the Thames, and the Elbe. One even traveled some 177 km (110 mi.) up the Columbia River in pursuit of fish.

Distribution

1. Depending on the ecotype, killer whales may exploit a variety of habitats, from shallow coastal areas to deep waters off the continental shelf.

2. Killer whales are found in the open ocean, but they seem to be most abundant in coastal waters.

3. Killer whales are most abundant in the Pacific Northwest, along northern Norway’s coast in the Atlantic and in the higher latitudes of the Southern Ocean.
4. In the North Atlantic, type 1 killer whales are found in the waters of the northeast Atlantic and Great Britain, while type 2 killer whales are mainly spotted off the west coast of Ireland and Scotland.

5. The five forms of Antarctic killer whales have different distributions.

   Type-A killer whales are circumpolar and live offshore in ice-free water.

   Type-B killer whales inhabit inshore waters of Antarctica and the Antarctic Peninsula; large type B near the pack ice; and small type B in more open waters.

   Type-C killer whales inhabit inshore waters and pack ice and are most common in the eastern Antarctic.

   The few sightings of type-D killer whales have been in deep, subantarctic waters.

6. The resident, transient, and offshore killer whales of the eastern North Pacific Ocean have overlapping but different distributions.

   Researchers have identified two distinct communities of resident whales, with different distributions. Whales in both communities tend to stay within about 800 km (500 mi.) of coastline. They tend to follow direct routes when traveling, from headland to headland.

   The northern resident stock occurs from the top half of British Columbia’s Vancouver Island north through Alaska.

   The southern resident stock occurs from the lower half of British Columbia’s Vancouver Island south through Washington State.

   The transient stock occurs from Alaska’s Aleutian Islands to Southern California. Transients may spend twice as much time traveling since their movements often follow the contours of the shoreline. Transient whales have been sighted within a 1,450 km (900 mi.) range.

   Offshore killer whales range from the Bering Sea to Southern California and have been sighted in both open-ocean and coastal habitats.

7. Eastern Tropical Pacific killer whales are usually sighted offshore and range from Southern California to the Mexican waters of the Pacific and Gulf of California.

Migration

1. In some areas, seasonal movements of killer whales are influenced by migration of their prey.

   Studies of movement patterns of fish-eating North Atlantic killer whales indicate that populations of these whales follow the movements of herring (Clupea harengus) in Icelandic and Norwegian waters and of mackerel in Scottish waters (North Atlantic Killer Whale ID Project). When the stock of herring in Norwegian waters changed its wintering distribution from inland fjords to offshore, the killer whales also changed their movements in response.

   In the North Pacific, resident pods tend to travel within specific, localized ranges while transient groups’ ranges are wider and less predictable. Both resident and transient killer whales in the North Pacific do not undertake “migration” in the formal sense of the word.

   The movements of resident pods in the Pacific Northwest coincide with the migration of their primary prey, salmon.

   Type A killer whales appear to be migratory, entering Antarctic waters during the austral summer.

   Type B (Antarctic killer whales) undertake rapid migrations from the Antarctic to subtropical waters off Uruguay and Brazil. These rapid travels may be over 5,800 miles (9,400 km) round trip. This migration may be for the purpose of maintenance, with the animals regenerating skin in warmer waters without the high cost of heat loss.

   A tagging study has shown that killer whales in the Canadian Arctic region also undertake long-distance movements, likely to avoid heavy ice formation in the winter months.

Population

1. Killer whales are difficult to census given their worldwide distribution. However, it’s estimated that their global population is at least 50,000.

2. With the exception of the southern resident community in the eastern North Pacific, killer whales are not listed as endangered or threatened.
Physical Characteristics

1. Adult male killer whales are larger overall than their female counterpart including features such as pectoral flippers, dorsal fins, tail flukes, and girth.

2. The largest recorded male killer whale was 9.8 m (32 ft.) in length and weighed 10,000 kg (22,000 lb.) The largest recorded female was 8.5 m (28 ft.) and weighed 7,500 kg (16,500 lb.)
3. Data from Icelandic killer whales indicate that an average-size male is about 5.8 to 6.7 m (19-22 ft.) long while females averaged 4.9 to 5.8 m (16-19 ft.) long.

4. Killer whale sizes vary significantly between different ecotypes.

   Male Antarctic type-A killer whales can reach lengths of 9.2 m (30 ft.), making them the largest known killer whales.

   The smallest killer whale ecotype is the Antarctic type-C killer whales in which adult females average 5.2 m (17 ft.) and adult males average 5.6 m (18 ft.) in length and can reach a maximum of 6.1 m (20 ft.)

5. At SeaWorld, average size for adult males is 6.6 m (21.7 ft.). Two of the largest adult male killer whales at SeaWorld weigh 4,340 kg (9,570 lb.) and 5,380 kg (11,860 lb.)

6. At SeaWorld, average size for females is 5.5 m (18 ft.) and 2,442 kg. (5,384 lb.) SeaWorld’s adult female whales range in weight from 2,313 kg (5,100 lb.) to 3,719 kg (8,200 lb.)

**Body Shape**

1. The general body shape of a killer whale 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).

**Coloration**

1. Killer whales are solid black and white, with a gray patch called a “saddle” or a “cape” on the back, just behind the dorsal fin.

   ![Image of killer whale coloration](http://seaworld.org/en/animal-info/animal-infobooks/killer-whale/physical-characteristics/)

   The dorsal surfaces are predominantly black with the exception of a gray “saddle” located behind the dorsal fin.

2. The large areas of black and white are distinctly separate.

   The entire dorsal (top) surface and pectoral flippers are black except for the gray saddle.

   The ventral (bottom) surface, lower jaw, and undersides of the tail flukes are mostly white. The undersides of the tail flukes are fringed with black.

   An oval, white "eyespot" is just above and slightly behind each eye.

   The size and shape of a killer whale’s white areas and gray saddle vary greatly among ecotypes.

   Conspicuous eye and saddle patches may help killer whales in groups coordinate social interactions, hunting, and swimming in formation.
3. The distinctive coloration of killer whales is a type of disruptive coloration, a pattern that obscures the outline of an animal by contradicting the animal’s body shape. In the flickering, filtered sunlight of the sea, other animals may not recognize a killer whale as a potential predator.

4. Killer whales are countershaded: the dorsal (top) surface is darker than the ventral (underneath) surface. When viewed from above, a countershaded animal blends in with the darker ocean depths. When viewed from below, the lighter belly surface blends in with the brighter sea surface.

5. While extremely rare, white killer whales have been observed. In British Columbia, one such animal was diagnosed with Chédiak-Higashi Syndrome, an inherited fatal disorder characterized by loss of pigmentation and not surviving to adulthood. Others appear to be full-grown adults and the cause of their white coloration is unknown.

Pectoral Flippers

1. A killer whale’s forelimbs are adapted for swimming. A killer whale uses its rounded, paddlelike pectoral flippers to steer and, with the help of the flukes, to stop.

2. Pectoral flippers have the major skeletal elements of the forelimbs of land mammals, but they are shortened and modified. The skeletal elements are rigidly supported by connective tissue.

3. Blood circulation in the pectoral flippers adjusts to help maintain body temperature.

4. The pectoral flippers of male killer whales are proportionately larger than those of females. A large male killer whale may have pectoral flippers as large as 2 m (6.5 ft.) long and 1.2 m (4 ft.) wide. A female’s pectoral flippers are significantly smaller.

Flukes

1. Each lobe of the two-lobed tail is called a fluke. Flukes are flat pads of tough, dense, fibrous connective tissue, completely without bone or cartilage.
Flukes are flattened pads of tough, dense, connective tissue with no bones.

2. A large male killer whale may have tail flukes measuring 2.75 m (9 ft.) from tip to tip.
3. Longitudinal muscles in the back one-third of the body (both above and below the spine) move the flukes up and down.
4. Like the arteries of the flippers, the arteries of the flukes are surrounded by veins to help maintain body temperature.

**Dorsal Fin**

1. Like the flukes, the dorsal fin is made of dense, fibrous connective tissue, without bones or cartilage.
2. Dorsal fin size and shapes vary between ecotypes.
3. The dorsal fin of a male killer whale is proportionately larger than that of a female. In adult males, the dorsal fin is tall and triangular. Reaching a height of up to 1.8 m (6 ft.) in a large adult male, it is the tallest dorsal fin of all cetaceans. In most females, the dorsal fin is slightly falcate (backward-curving) and smaller—about 0.9 to 1.2 m (3–4 ft.) tall.
4. As in the flukes and the flippers, arteries in the dorsal fin are surrounded by veins to help maintain body temperature.
5. Like the keel of a boat, the dorsal fin may help stabilize a killer whale as it swims at high speeds, but a fin is not essential to a whale’s balance.
6. Some killer whales (both male and female) have irregular-shaped dorsal fins: they may be curved, wavy, twisted, scarred, or bent. Of the 30 adult male killer whales that have been photo-identified in New Zealand waters, seven have collapsing or bent dorsal fins.
7. Killer whales in the Eastern Tropical Pacific tend to have barnacles (*Xenobalanus spp.*) attached to the back edge of their dorsal fins.

**Head**

1. A killer whale has an indistinct rostrum (snoutlike projection).
2. A single blowhole on top of the head is covered by a muscular flap. A killer whale breathes through its blowhole. The blowhole is relaxed in a closed position, and the flap provides a water-tight seal. To open its blowhole, a killer whale contracts the muscular flap.
3. A killer whale’s eyes are on each side of its head, just behind and above the corner of its mouth, and in front of its white eyespot.
4. A killer whale’s eyes are about the same size as the eyes of a cow. Glands at the inner corners of the eye
sockets secrete an oily, jellylike mucus that lubricates the eyes, washes away debris, and probably helps streamline the eyes as a killer whale swims.

5. Ears are small inconspicuous dimples just behind each eye, with no external flaps or pinnae. These small external ear openings lead to reduced ear canals that are not connected to the middle ears.

**Teeth**

1. A killer whale’s large teeth are conical and interlocking. Toothed whales have only one set of teeth; they are not replaced once lost.

2. The number of teeth varies among individuals. There are usually 10 to 14 teeth on each side of each jaw (40–56 teeth total.)

3. A killer whale does not chew its food—instead its teeth are adapted to grasp prey and tear its food into smaller chunks.

4. Teeth are about 7.6 cm (3 in.) long and about 2.5 cm (1 in.) in diameter.

5. The teeth of killer whales begin to erupt from several to 11 weeks of age, which corresponds with the time that calves are seen taking solid food from their mothers.

6. Extensive wear has been noted on the teeth of older individuals. Most adult North Atlantic type 1 killer whales have severely worn-down teeth, which is consistent with a diet of suctioning up small fishes. Adult offshore killer whales in the Northeast Pacific also have highly worn teeth, likely caused by a diet that includes sharks with highly abrasive skin.

**Skin**

1. A killer whale’s dermis (skin) is smooth. The outer layer continually and rapidly renews itself, and the old skin sloughs off.

2. The increased skin cell turnover increases swimming efficiency by creating a smooth body surface which reduces drag.

**Blubber**

1. A killer whale’s blubber layer lies beneath the dermis and measures from 7.6 to 10 cm (3–4 in.) thick. Blubber is a layer of fat reinforced by collagen and elastic fibers. In general, blubber has a number of important functions:

   - Contributing to a killer whale’s streamlined shape, which helps increase swimming efficiency.
   - Storing fat, which provides energy when food is in short supply.
   - Reducing heat loss, which is important for thermoregulation.

**Physical Differences in Ecotypes**

1. The five forms of Antarctic killer whales look different and are easier to tell apart.

   Type-A killer whales have a medium-size, horizontal eye patch and have a very faint dorsal saddle. These are the largest killer whale ecotypes.

   Large type-B killer whales have very large, horizontal eye patch. The small type-B killer whale has a slightly narrower and slanted eye patch. Both types have a dorsal saddle, a dorsal cape (dark gray covering on the back), and can have a yellowish cast due to a layer of diatoms on their skin.

   Type-C killer whales have a small, forward-slanting eye patch and a dorsal saddle and often have a yellowish cast due to a covering of diatoms. These are the smallest type of killer whale.

   Type-D killer whales have an extremely, tiny eye patch, a bulbous melon (forehead), and a very faint saddle.

   Experts note subtle differences between the resident, transient, and offshore killer whales of the eastern North Pacific Ocean.

   In general, resident killer whales are larger and have a rounded tip on the dorsal fin, which is falcate (curved back) in adult females and tall and triangular in males. The dorsal saddle may contain some black areas.

   Transient killer whales tend to be smaller and have a more pointed dorsal fin. The dorsal saddle...
KILLER WHALES (Orcinus orca) - Physical Characteristics

Offshore killer whales are more similar in appearance to the resident ecotype, although they are smaller than either the residents or transients and they have a faint saddle.


Type 1 killer whales are much smaller than type 2. They have very distinct white patches and a conspicuous saddle.

Type 2 killer whales are one of the largest ecotypes, with males reaching 8.5 m (29 ft.) lengths. They have very distinct white patches, a slanted-back eyepatch, and a faint saddle.

Photo-Identification of Individual Whales

1. Of the groups of killer whales studied, researchers have learned to recognize many individual killer whales from photographs, especially photos of the dorsal fin and saddle patch.

Researchers photograph the dorsal fin when the whale rises out of the water to breathe. This action exposes the most markings on the back and dorsal fin. Studying the photos, these researchers recognize subtle differences in whales’ body appearance.

Researchers identify individuals using many features including dorsal fin shape, nicks in the dorsal fin, relative body size, pigmentation patterns of saddle patches and eye patches, scars, deformities, detail of tail fluke edges, encrustations, blemishes, and rake marks.

2. Photo-identification is an important research tool for studying various aspects of cetacean biology, including movements, reproduction, behavior, social structure, and population dynamics. Photo-identification helps document the lives of individual whales in considerable detail.
Senses

Killer Whales

Hearing

1. Killer whales have a well-developed, acute sense of hearing. A killer whale’s brain and nervous system appear physiologically able to process sounds at much higher speeds than humans, most likely because of their echolocation abilities.

2. Soft tissue and bone conduct sound to a toothed whale’s middle and inner ears. In particular, fat lobes in the whale’s lower jaw appear to be an adaptation for conveying sound to the ears.

3. In killer whales, the ear bone complex (otic capsule) isn’t attached to the skull. Ligaments hold each ear bone complex in a cavity outside the skull. This separation of the ear bone complex allows a killer whale to localize sound (directional capacity), which is important for echolocation.

4. Hearing range.

   Early studies published in 1972 suggested that the hearing range of killer whales was about 0.5 to 31 kHz. More recent studies show killer whales could hear sounds at frequencies as high as 120 kHz. Greatest sensitivity ranged from 18 to 42 kHz with the least sensitivity to frequencies from 60 to 120 kHz.

   In comparison, the range of hearing of a young, healthy human is 15 to 20,000 Hz (0.015–20 kHz.) Human speech falls within the frequency band of 100 to 10,000 Hz (0.1–10 kHz), with the main, useful voice frequencies within 300 to 3,400 Hz (0.3–3.4 kHz.) This mainly falls within a killer whale’s hearing range.

Eyesight

1. Killer whale vision is well developed.

   Studies in marine life parks have shown that killer whales have acute vision both in and out of water. In these studies, killer whales visually discriminated among similar objects. During more than one hundred trials, a killer whale was shown an object and cued to find a matching object. When given two choices, the whale chose the matching object with 92% accuracy, and when three choices were presented the whale’s accuracy was about 82%. Researchers did not determine whether the whale was responding to shape, size or color. Future studies may provide more detailed information on the visual abilities of killer whales.

   The eyes are located in front of and below the eye spot.

2. The lens of a marine mammal’s eye is stronger than that of a land mammal.
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.

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.

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.

3. DNA analysis of several other species of toothed whales indicated that the eyes of these whales do not develop pigment cells called short-wave-sensitive (S-) cones, which are sensitive to blue light. Researchers theorize that all modern cetaceans, including killer whales, lack these visual pigments and therefore aren’t able to discriminate color in the blue wavelengths.

Tactile

1. Anatomical studies and observations of behavior indicate that a killer whale’s sense of touch is well developed. Studies of closely related species (common dolphins, bottlenose dolphins, and false killer whales) suggest that the most sensitive areas are the blowhole region and areas around the eyes and mouth.

Taste

1. In zoological parks, killer whales show strong preferences for specific types of fishes. Overall, however, little is known about a whale’s sense of taste.

2. Behavioral evidence suggests that bottlenose dolphins, a closely related species, can detect three if not all four primary tastes. The way they use their ability to “taste” is unclear.

3. Scientists are undecided whether dolphins have taste buds like other mammals. Three studies indicated that taste buds may be found within 5 to 8 pits at the back of the tongue. One of those studies found them in young dolphins and not adults. Another study could not trace a nerve supply to the taste buds. Regardless, behavioral studies indicate bottlenose dolphins have some type of chemosensory capacity within the mouth.

Smell

1. Olfactory lobes of the brain and olfactory nerves are absent in all toothed whales, indicating that they have no sense of smell. Being air-breathing mammals that spend a majority of time under water, a sense of smell would go largely unused in killer whales.
Adaptations

Scientific Classification
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Killer Whales
Adaptations For An Aquatic Environment

Swimming

1. Killer whales are among the fastest swimming marine mammals.
   Killer whales can swim at speeds of up to 45 kph (28 mph), but probably only for a few seconds at a time.

2. Killer whales are agile and maneuverable in the water.

3. When swimming near the surface, a killer whale usually stays below water for 30 seconds or less.

4. Swimming energetics.
   Blubber smooths the contour of a killer whale and contributes to its characteristic fusiform shape, which 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).

   Killer whales and many other toothed whales sometimes "porpoise" at the surface: they swim fast enough to break free of the water, soaring briefly up and out and then back under in one continuous movement, which they generally repeat. Porpoising uses less energy than swimming fast at the surface.

   Wave-riding also saves energy. Killer whales and many other toothed whales sometimes ride ocean swells or a boat's bow wave or stern wake. Riding a wave or a wake, a killer whale can go almost twice as fast using the same energy cost.

   A killer whale calf swims close to its mother and can be carried in the mother's "slip stream," a type of hydrodynamic wake that develops as the mother swims. This helps the calf swim with less energy and enables the mother and calf to keep up with the pod.

Diving

1. Dive depth.
   Although not generally deep divers, foraging killer whales can dive to at least 100 m (328 ft) or
The deepest dive known for a killer whale, performed under experimental conditions, was 259 m (850 ft.)

A study of southern resident killer whales in the North Pacific recorded an animal diving up to 264 m (866 ft.)

Researchers believe that at least some killer whales can dive to at least 350 m (1,148 ft.) Adult males killer whales dive more often and deeper than adult females.

2. Dive duration.

In the eastern North Pacific, resident killer whales usually make three or four 15-second dives and then a dive that lasts about 3 to 4 minutes, repeating this pattern.

Average dive duration for resident killer whales is approximately 2.3 minutes.

Transient killer whales have been recorded diving for up to 11.2 minutes. Transient whales in the eastern North Pacific often stay submerged for more than 5 minutes and occasionally for more than 15 minutes in a single dive.

3. All marine mammals have physiological responses for diving. These responses enable a killer whale to conserve oxygen while under water.

Killer whales, like other mammals, have a slower heart rate while diving. One study indicated that a killer whale’s heart rate at the surface of the water is approximately 60 beats per minute, but while diving the rate fell to 30 beats per minute.

When diving, blood is shunted away from tissues tolerant of low oxygen levels toward the heart, lungs, and brain, where oxygen is needed most.

Certain protein molecules—hemoglobin and myoglobin—store oxygen in body tissues. Hemoglobin occurs in red blood cells. Marine mammals have a higher blood volume and more hemoglobin than comparatively sized land mammals. Myoglobin occurs in muscle tissue. The muscle of whales has a higher myoglobin concentration than the muscle of land mammals.

4. Both humans and cetaceans can experience negative physiological impacts from diving.

As pressure increases with depth, the amount of gas that goes into solution in a diver’s blood and body tissues also increases. At about two atmospheres of pressure (about 60 ft.), tissues are saturated. If a human diver returns to the surface too quickly, the gases, especially nitrogen, come out of solution and form bubbles in the muscles and blood. This painful and sometimes fatal condition is called “the bends.”

The “bends” is most common in scuba divers, but human breath-hold divers can also get the bends from deep diving. Human breath-hold divers dive on fully inflated lungs. Under pressure, a human’s bronchioles collapse. Lung air is forced into the alveoli: the numerous tiny areas of the lungs where gas exchange takes place. Here gases are absorbed under pressure.

Unlike human scuba divers, a whale doesn’t breathe air under pressure. It inhales only at the surface and exhales just before diving. Furthermore, in diving mammals, the alveoli collapse at about 3 atmospheres of pressure, forcing air into the rigid peripheral airways where gases are not exchanged.

**Respiration**

1. A killer whale breathes through a single blowhole on top of its head.
The blowhole is relaxed in a closed position. To open the blowhole, a killer whale contracts the muscular flap covering the blowhole.

A whale holds its breath below water.

A killer whale opens its blowhole and begins to exhale just before reaching the surface of the water.

At the surface, the whale quickly inhales and closes the muscular flap.

A killer whale breathes air through its blowhole on top of its head.

The visible spout of water that rises from a killer whale’s blowhole is not coming from the lungs, which (like ours) do not tolerate water.

Water that is on top of the blowhole when the powerful exhale begins is forced up with the exhaled respiratory gases.

Especially in cool air, a mist may form; it is water vapor condensing as the respiratory gases expand in the open air.

When a whale breathes, the visible blow that appears to be water is really water vapor condensing in the respiratory gases as they expand in the cooler ambient air.

In comparison to a human, a killer whale can hold its breath longer and exchange more lung air with each breath.

The resting respiratory rate of killer whales at SeaWorld is about three to seven breaths every five minutes.

Thermoregulation

Like all mammals, killer whales are warm-blooded. A killer whale’s core body temperature is about 36.4° to 38°C (97.5°–100.4°F)—close to that of a human. Living in the sea poses a particular challenge to marine mammals, because water conducts heat about 25 times faster than same-temperature air.

The large size of a killer whale helps minimize heat loss.

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.

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.

Just under a killer whale’s skin lies a thick layer of blubber, composed of fat cells and fibrous connective tissue. Blubber helps insulate a whale from heat loss. There is a heat gradient from the body core,
1. In general, killer whales have a higher metabolic rate than land mammals of similar size. This increased metabolism generates a great deal of body heat.

2. Mammals lose body heat when they exhale. Because they breathe less frequently than land mammals, killer whales conserve a considerable amount of heat.

3. A killer whale’s circulatory system helps maintain body temperature; it adjusts to conserve or dissipate body heat.

   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.

   When a killer whale dives, circulation decreases at the skin, shunting blood to the insulated body core.

   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.

   In male killer whales, a countercurrent heat exchange system cools arterial blood that is flowing to the testes. Another countercurrent heat exchange system regulates the temperature of a developing fetus in gestating females.

4. Several species of cetaceans, including the bottlenose dolphin and beluga whales, have been shown to engage in unihemispheric slow wave sleep (USWS) during which one half of the brain goes into a sleep state, while the other maintains visual and auditory awareness of the environment and allows the animal to resurface for respiration. This ability may help to avoid predators as well as maintain visual contact with cohorts/offspring. Dolphins have one eye closed during USWS.

5. Observers note that killer whales typically rest, motionless, at various times throughout the day and night for short periods of time or for as long as eight hours straight. While resting, killer whales may swim slowly or make a series of three to seven short dives of less than a minute before making a long dive for up to three minutes. Resident killer whales often rest in a group, lined up alongside each other.

6. When sleep researchers studied two newborn killer whale calves and their mothers at SeaWorld San Diego, they discovered that the mothers and calves didn’t appear to sleep or rest at all for the first month of a calf’s life. Over the next several months, the whales gradually increased the amount of time they spent resting to normal adult levels. Four bottlenose dolphin calf-mother pairs showed the same sleep-behavior pattern. Staying active and responsive after birth may be an adaptation for avoiding predators and maintaining body temperature while the calf builds up a layer of blubber.
Communication & Echolocation

Sound in the Sea

1. Sound waves travel through water at a speed of about 1.5 km/sec (0.9 mi/sec), which is four-and-a-half times as fast as sound traveling through air.

2. Killer whales probably rely on sound production and reception to navigate, communicate, and hunt in dark or murky waters. Under these conditions, sight is of little use.

Sound Production

1. Killer whales produce sounds for two overlapping functions: communicating and navigation (in the form of echolocation).

2. Killer whales produce whistles, echolocation clicks, pulsed calls, low-frequency pops, and jaw claps.

3. A killer whale makes sounds by moving air between nasal sacs in the blowhole region.

   In contrast, a human makes sound by forcing air through the larynx. The vocal cords in the larynx vibrate as air flows across them, producing sounds. Our throat, tongue, mouth and lips shape these sounds into speech. The larynx of a killer whale does not have vocal cords.

   A tissue complex in a toothed whale's nasal region, called the dorsal bursa, is the site of sound production. This complex includes "phonic lips" (sometimes called "monkey lips")—structures that project into the nasal passage. Toothed whales make at least some sounds by forcing air through the nasal passage and past the phonic lips: the surrounding tissue vibrates, producing sound.

   During some vocalizations, killer whales actually release air from the blowhole, but these bubble trails and clouds are probably a visual display. Releasing air isn't required for sound production.

   A killer whale can produce sound from at least two separate sources in its complex of nasal sacs.

Communication

1. Killer whales use whistles for close-range, or private, communication and coordination of behavioral interactions between animals. Whistles are high pitched, show a high degree of directionality and highly modulated, as a result, they don't carry far underwater.

   The frequency of killer whale whistles ranges from about 0.5 to 40 kHz, with peak energy at 6 to 12 kHz.

   Studying northern resident killer whales, researchers found that the whales produced more whistles when they were close to other individuals and only sporadically emitted them when the whales were dispersed over larger areas.

   Transient killer whales also use whistles, but more sparingly and have a smaller repertoire in comparison to residents.

2. Pulsed calls are the most common vocalization of killer whales.

   Experts think these calls function in group recognition and coordination of behavior.

   Killer whales make these calls at frequencies of about 0.5 to 25 kHz, with peak energy at 1 to 6 kHz.
3. Calls that sound the same time after time are called *stereotyped calls*. All a killer whale’s stereotyped calls make up that whale’s *repertoire*.

4. The individuals of any particular pod share the same repertoire of calls, a vocalization system called a *dialect*.

   Although scientists have noted that there is some type of structure to the calls, a dialect is not the same thing as a language.

   Analysis of killer whale call patterns has demonstrated substantial differences between the dialects of different pods.

   Pods that associate with one another may share certain calls. Pods that share calls are called a *clan*.

   Pods may share a certain level of their repertoire with other pods while other portions are unique. The more similarities they share may indicate the degree the pods and individuals are related.

   No two pods share the entire repertoire. Thus, each pod has its own unique dialect. In fact, the vocal repertoires of each pod remain distinct enough that scientists can identify pods by the sounds they make.

   Killer whales that are separated by great geographical distances have completely different dialects. An analysis of Icelandic and Norwegian killer whale pods revealed that the Icelandic population made 24 different calls and the Norwegian whales made 23 different calls, but the two populations did not share any of the same calls.

5. A calf is most likely to develop calls like those of its mother. Vocal development studies at SeaWorld have determined that a calf learns its repertoire of calls selectively from its mother, even when other killer whales may be present and vocalize more frequently than the mother.

   A calf can vocalize within days of birth, but sound production is shaped with age. A calf’s first vocalizations are “screams”-loud, high-pitched calls that bear no resemblance to adult-type calls.

   At about two months, a calf produces its first pulsed calls with similarities to adult-type calls.

   Vocal behavior appears not to be genetically predetermined. Calves learn which calls to make and under what circumstances.

   From two to six months, a calf’s repertoire increases. Calves continue to learn calls until puberty.

6. Like many other animals, toothed whales may also communicate using a variety of postures and gestures. Some behaviors, such as head-butting and jaw-snapping, are usually assumed to communicate aggression. The purpose of other behaviors, including breaching and pec-slapping, is not clearly understood.

### Echolocation

1. The term *echolocation* refers to an ability that odontocetes (and some other marine mammals and most bats) possess that enables them to locate and discriminate objects by projecting high-frequency sound waves and listening for echoes.

2. A killer whale echolocates by producing clicks and then receiving and interpreting the resulting echo.

   The echolocating killer whale uses its phonic lips to produce directional, broadband clicks in rapid succession, called a train. Each click lasts less than one millisecond. One study of resident killer whales measured broadband, bimodal echolocation clicks that typically showed low frequency peaks between 20 to 30 kHz and high frequency peaks between 40 to 60 kHz.

   The click trains pass through the melon (the rounded region of a killer whale’s forehead), which consists of lipids (fats). The melon acts as an acoustical lens to focus these sound waves into a beam, which is projected forward into water in front of the whale.

   The sound waves produced by a killer whale bounce off objects in the water, and their echoes return to the killer whale.

   The major areas of sound reception are the fat-filled cavities of the lower jaw bones. Sounds are received and conducted through the lower jaw to the middle ear, inner ear, and then to hearing centers in the brain via the auditory nerve.

3. Killer whales often need to navigate in the absence of light/good visibility. Therefore, hearing is essential to them. The killer whale’s primary sensory system is the auditory system. It is a highly-developed system that includes biological sonar ability or echolocation. Echolocation helps killer whales determine the size, shape, structure, composition, speed, and direction of an object.
Killer whales echolocate by producing high frequency clicks that pass through the melon, then receiving and interpreting the resulting echo.

**Relationship to Feeding Habits**

1. The use of echolocation and calls may vary greatly between fish-eating and mammal-eating populations of killer whales.

2. In the North Pacific, resident killer whales are more vocal and 27 times more likely to be producing a click trains for echolocation. However, transients are 4 times more likely to produce single clicks than residents. These differences are likely due to the fact that transients prey on mammals, with excellent hearing, and attempt to go unnoticed by producing less sound and using echolocation sparingly.
Behavior

Killer Whales

Behavior Observation

1. For the most part, killer whales in the wild are visible only when they are at the surface, so it is inherently challenging to document and study whale behavior.

2. Possibly the most-studied killer whales in the wild are the resident killer whale communities of the eastern North Pacific Ocean.

   Much of what we know about killer whales comes from studying these whales.

   Ecotypes of killer whales can be very different from one another in diet, appearance, dialect, and genetics. Experts use caution when generalizing about killer whales, knowing that the different ecotypes of killer whales that have not been as well studied may be quite different from the eastern North Pacific resident whales.

Social Structure

1. Killer whales live in cohesive long-term social units called pods. A pod is a group of individuals that travel together the majority of the time. A pod is a group of related matrilineals that probably shared a recent maternal ancestor. Pods are less stable and it's not unusual for a subpod to break away from the pod for an extended period of time.

   Pod size can vary tremendously. In the eastern North Pacific Ocean, pod size varies from just two or three to more than 100 individuals. In general, resident pods are larger than transient pods.

   Resident pods usually include between five and 50 whales.

   Transient pods usually include only seven whales or less. In fact, some transient “pods” consist of a solitary adult male. Rarely, transient pods come together to form groups of 12 or more. More than 30 individuals were spotted in a transient killer whale pod in the western Okhotsk Sea.

   Offshore killer whales are sighted in groups of less than 20 to more than 100 individuals.

   Off Alaska and Antarctica, groups of more than 100 animals have been observed. Larger groups of 130 to 500 individuals have also been seen, with one report of a gathering of an estimated 2,500 individuals. These larger groups may be due to seasonal prey aggregations, for social interaction, or for mating.

   Scientists theorize that these differences in pod size are related to the whales’ feeding habits. A large pod size may be best for herding and hunting schools of fish, and a small pod may be best for hunting marine mammals.

   A subpod contains generally one or more matrilineal groups that typically always travel together. Sometimes a subpod will temporarily break away from its pod.

   The most fundamental social unit in a pod is a matrilineal group, which may include two or three generations of whales. A two-generation matrilineal group consists of a female whale and her offspring. A three-generation matrilineal group also includes her “grandchildren,” the offspring of her female offspring. Individuals in a matrilineal group travel closely together.

   In the North Pacific, the largest matriline of resident killer whales recorded to travel together
consisted of five generations.

Killer whales live in social groups called pods.

2. A clan is a social level above the pod level. Clans are made up of pods in an area with similar dialects and are thought to be related. These pods may have developed from one ancestral pod that grew and fragmented over time. Pods from different clans are frequently seen traveling together.

3. A community is a group of killer whales that share a common range and associate with one another.

There may be several pods within a community.

Along the coastal waters of British Columbia, Washington and Alaska, three communities of residents have been documented.

Pods from one community have rarely or never been observed traveling with those of another, even when their ranges overlap.

Occasionally there is an exchange of pods members, such as for breeding purposes.

A pod is a group of individuals that travel together the majority of the time.

4. Off Alaska and Antarctica, groups of more than 100 animals have been observed. Larger groups of 130 to 500 individuals have also been seen, with one report of a gathering of some 2,500 individuals. Researchers are uncertain why killer whales form such large groups at times.

Social Behavior

1. Killer whales in a pod establish strong social bonds. Observers note that certain individuals are regularly seen associating with one another.

2. The strongest association bonds in a pod are the mother/calf bonds.

A mother killer whale stays close to her newborn calf and attentively directs its movements.

The mother/calf bond weakens as a young killer whale matures, but for resident whales of the eastern North Pacific, it lasts throughout adulthood. In fact, these resident killer whales societies are unique in that a juvenile killer whale does not leave its mother or disperse from its maternal pod when it matures.

In transient pods of the eastern North Pacific Ocean, a whale may leave its mother to travel alone or with other whales.
3. As with many species, a social hierarchy exists within a group of killer whales. The hierarchy is female-dominant.

Killer whales within a pod may rank themselves and establish dominance by slapping their tails against the water, head-butting, jaw-snapping, biting, raking (tooth-scratching), and various other vigorous postures and gestures.

SeaWorld observers noted that calves receive social discipline from their mothers and other significant adults. Discipline may be in the form of restraining (corralling the calf thus restricting its movements) or raking (tooth scratching).

4. Killer whales often hunt together. (See Diet: Food Preferences & Resources and Diet: Methods of Collecting Food)

5. Interactions between resident and transient pods have not been observed. When they are traveling in the same area, they most often appear to ignore each other. At other times, transient whales actively avoid resident whales.

**Individual Behavior**

1. Whale watchers and researchers have named certain common whale behaviors.

   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.

   A *spyhop* is a behavior in which a whale rises out of the water somewhat vertically, exposing its head.

   *Lob-tailing* (slapping the tail flukes on the surface of the water), *dorsal fin slapping* (rolling onto one side to slap the fin on the surface of the water), and *pec-slapping* (slapping a pectoral flipper on the surface of the water) create loud sounds above water and under water.
A spyhop is when a killer whale hangs vertically in the water with its head partially above water.

2. Killer whales in the Johnstone Strait in British Columbia rub their bodies along the pebbly bottoms of shallow bays (sometimes called “rubbing beaches.”) They may do this to help remove sloughing off skin.

3. Behavioral studies suggest that killer whales “play” with and manipulate objects.

**Stranding**

1. A killer whale may strand if it is affected by a severe, debilitating illness or injury, or if it is too weak to swim or hunt for food. (See Longevity and Causes of Death.)

2. In some areas, killer whales temporarily slide up onto ice or sand to pursue prey. This behavior is not considered stranding.

**Interaction with other Marine Mammals**

1. Killer whales prey on many species of marine mammals. (See Diet.)

2. Killer whales have also been observed harassing other marine mammals, without eating them.

3. At other times, killer whales have been seen feeding in the same area with other marine mammals, with no apparent reaction by the killer whales. Some species, including those that are known prey for killer whales (minke whales, Dall’s porpoises, and seals, for example) have been observed swimming with killer whales.

4. Other marine mammals may flee or avoid killer whales, but at times they seem to ignore them. Sometimes other marine mammals appear to be attracted to killer whales.
Diet & Eating Habits

Killer Whales

Food Preferences & Resources

1. Active and opportunistic, killer whales are top-level predators in the ocean. Killer whales are the largest predator of warm-blooded animals alive today.

2. Globally, killer whales appear to have an extremely diverse diet. Yet, individual ecotypes or populations are often extremely specialized. In many parts of the world, killer whales prey on fishes or marine mammals, but not both.

3. Worldwide, killer whales have been observed preying on more than 140 species of animals, including many species of bony fish, sharks and rays, and 50 different species of marine mammals.

4. Killer whales have also been reported to eat many other types of animals including leatherback sea turtles, dugongs, moose, and penguins and other seabirds.

5. Each killer whale ecotype has a fairly specific diet.

The five forms of Antarctic killer whales differ in their diet:

- **Type-A** whales eat mostly Antarctic minke whales and have also been observed hunting southern elephant seals.
- Large **type-B** whales eat mainly seals, especially Weddell seals, and also hunt minke whales.
- Small **type-B** killer whales have been observed hunting penguins and are believed to mainly eat fishes.
- **Type-C** killer whales mostly eat Antarctic toothfish (*Dissostichus mawsoni*).
- Little is known about the diet of **type-D** killer whales, however, they have been observed preying on Patagonian toothfish (*Dissostichus eleginoides*) caught on longlines.

The feeding habits of resident and transient whales of the eastern North Pacific Ocean differ.

- **Resident** whales spend about 60% to 65% of daylight hours foraging for fishes. Salmon make up 96% of their diet; Chinook salmon (*Oncorhynchus tshawytscha*) is the preferred species. Their diet is highly specialized and this dependence may be a limiting factor for this population. To a much lesser degree, residents are also known to eat one species of squid (*Gonatopsis borealis*) and 22 other species of fish including rockfish (*Sebastes spp.*), Pacific halibut (*Hippoglossus stenolepis*) and Pacific herring (*Clupea pallasi*). There is no evidence of resident killer whales eating marine mammals.
- **Transient** whales spend about 90% of daylight hours foraging. They primarily eat marine mammals including seals, sea lions, walruses, baleen whales, other toothed whales, and occasionally sea otters.

Researchers theorize that the divergent, specialized feeding habits of resident and transient killer whales help prevent these two groups of whales from competing with each other for food.

Such extremely different feeding habits, which is not known to occur in any other sympatric mammal species, has also resulted in significant differences in vocalizations, echolocation, group size and behavior between the two ecotypes.

The diet of offshore killer whales in the northeastern Pacific include fishes such as salmon.
KILLER WHALES (Orcinus orca) - Diet & Eating Habits

(Oncorhynchus spp.), sculpin (Cottus spp.), Pacific halibut (Hippoglossus stenolepis) and Pacific sleeper sharks (Somniosus pacificus).

In the North Atlantic, the type 1 killer whales consume a varied diet that includes seals and small, schooling fishes such as herring and mackerel. Type 2 killer whales specialize in cetacean prey including dolphins, porpoises, and baleen whales such as minke whales.

Although rarely seen, killer whales in Hawaiian waters seem to have a more varied diet including humpback whales, dolphins, octopuses and squids.

Food Intake

1. At SeaWorld parks, adult killer whales eat approximately 2% to 4% of their body weight in food per day.
2. Growing calves eat more - as much as 10% of body weight during growth periods.

At zoological parks, calves begin to take a few fish at about two to three months.

A killer whale's lower teeth emerge at about four months.

By the age of one year, calves at SeaWorld eat 23 to 27 kg (50–60 lb.) of herring, smelt, and squid per day.

3. Killer whales don’t chew their food. They swallow their food whole, or they may tear or shred it.

Methods of Collecting Food

1. Killer whales often hunt cooperatively in pods for food.

Salmon-eating resident killer whales in the North Pacific often pursue prey singularly or in small groups. After a successful kill they regularly (75% of the time) share their fish, usually family members and particularly offspring.

At times killer whales work together to encircle and herd small prey before attacking. The comparatively large pod size of resident whales is an advantage when herding a school of fish.

Researchers observed Norwegian killer whales hunting cooperatively using a “carousel-feeding” technique. They cooperatively herded small fishes into a tight ball close to the surface. Then the whales stunned the fishes with their tail flukes and ate the stunned fish.

To hunt a large baleen whale, a pod of killer whales may attack the whale from several angles. One attack was witnessed by SeaWorld researchers. About 30 killer whales attacked an 18.2-m (60-ft.) blue whale. Two killer whales stayed ahead and two brought up the rear while the others surrounded the blue whale from the sides and underneath in an apparent effort to prevent escape. Some leaped onto its back. The whales took turns biting flesh and blubber from their prey. After five hours the pod broke off the attack.

A New Zealand researcher described a group of seven killer whales hunting a shortfin mako shark (Isurus oxyrinchus). The whales thrust their tail flukes underwater to force the shark toward the surface, then struck the shark with their tail flukes before killing and eating it.

Transient pods “sneak-attack” marine mammals. These small groups most often hunt quietly or silently. Other observed transient hunting techniques include driving and trapping groups of Pacific white-sided dolphins in confined bays and ramming sea lions with their heads or stunning them with tail fluke swats before taking the animal underwater and drowning it.

In the Antarctic, individual killer whales slide out onto ice floes to hunt penguins. Similarly, killer
whales sometimes slide up onto sand bars or beaches to hunt pinnipeds such as juvenile elephant seals.

Antarctic killer whales sometimes hit ice floes from below to knock prey into the water. When an ice floe is too big to be overturned, Antarctic type B killer whales will swiftly swim side-by-side at the ice floe, diving below the floe at the last second, to create a wave large enough to wash a hauled out seal into the water.

Sometimes killer whales feed in connection with fisheries operations, eating fishes that slip from the nets and bycatch (nontarget fish caught during a fishing operation) discarded by fishermen. In some areas, killer whales congregate near longline boats and feed on the hooked fish.

2. Killer whales also hunt individually.

In the Antarctic, killer whales slide out onto ice floes to hunt penguins. Similarly, killer whales sometimes slide up onto sand bars or beaches to hunt sea lions.

Killer whales sometimes hit ice floes from below to knock prey into the water.

An encounter between a great white shark (*Carcharodon carcharias*) and killer whales was documented off of Southeast Farallon Island near San Francisco, California.

Two killer whales were in the area feeding on a California sea lion (*Zalophus californianus*)—a favored food of great whites. Perhaps the smell of fresh sea lion blood drew the shark to the area, but once one of the killer whales sighted the great white it immediately charged and contacted the shark under water.

The killer whale pulled the 3 to 4 m (10-13 ft.) shark to the surface in its mouth and the killer whales consumed sections of the great white such as its enormous liver.

This is certainly no indication of what may happen every time killer whales face great whites, but it does demonstrate the variety of a killer whale’s diet.

Prey such as these sea lions, may not be safe from killer whales even on land.

Killer whales possess sharp, cone-shaped teeth adapted for ripping and tearing prey.
10/1/2015

KILLER WHALES (Orcinus orca) - Reproduction

Reproduction

Scientific Classification
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Killer Whales

Reproduction

Sexual Maturity

1. Many aspects of killer whale reproduction are not known because they are difficult to study in the wild. Much of what we know about killer whale reproduction comes from studies of killer whales in marine zoological parks.

2. Depending on the geographic area studied, females are estimated to become sexually mature when they reach about 4.6 to 5.4 m (15-18 ft.) in length, which corresponds to ages between 7 to 16 years. Zoological studies demonstrate a narrower age of sexual maturity in females from 6 to 8 years of age.

3. Depending on the ecotype, males become sexually mature when they reach body lengths ranging from 5.2 to 6.4 m (17-21 ft.) in length, which corresponds to ages between 10 to 17.5 years (an average of about 15 years.)

4. Based on serum testosterone concentrations, killer whale males in zoological parks (mainly Icelandic in origin) reached puberty from 8 to 12 years of age at 4.9 m (16 ft.) and were sexually mature from 13 years of age and greater than 5.5 m (18 ft.) in length.

5. In males, dorsal fin growth is probably a secondary sex characteristic. Captive studies demonstrate that dorsal fin height to length ratio of 1.4 was associated with sexual maturity in wild males, but it has been demonstrated that males can reach this ratio 1 to 2 years prior to reaching sexual maturation.

At SeaWorld one male successfully mated at about 8 years of age, but in the wild, social factors greatly influence a male's breeding success. Male killer whales in the wild may not successfully reproduce until they are much older, larger, and able to compete with other males.

6. Female killer whales exhibit reproductive senescence (eg. menopause). Resident female killer whales in the north Pacific have not been known to reproduce after 46 years of age, and 50% of the females do not reproduce after 38 years of age.

Mating Activity

Marine life parks have been able to learn a great deal about killer whale reproduction.

1. Females come into estrus or “heat” several times during the year.

   Observations of females in zoological parks indicate that killer whales undergo periods of multiple estrous cycling (polyestrus), interspersed with periods of noncycling. On average, females may have four estrous cycles during one polyestrus period. This period is highly variable, as is the period of noncycling, both for one whale over time, and between whales.

2. Killer whales are polygamous: they mate with several partners.
Birth & Care of Young

Scientific Classification
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Killer Whales
Birth & Care of Young

Gestation
1. Gestation is about 17 months. Killer whale pregnancies at SeaWorld parks have ranged from 15.7 to 18 months.

Birth Seasons
1. Calves are born throughout the year, with no statistical evidence for birth seasons.
2. However, while males produced sperm throughout the year, peak testosterone and sperm production corresponded to months from March to June in North American zoological facilities.
3. Specific regions may have peak birth months. For example, in the northeast Pacific Ocean, many calves are born between October and March.

Calving
1. Just one calf is born at a time. Calves are born in the water.
2. Most deliveries observed have been tail-first, but head-first deliveries also have been observed.
3. Based on limited data collected from populations at sea and in zoological facilities, a female may bear a calf every three to five years. In some cases, a female may not have another calf for ten years.
Calves at Birth

1. Size estimates of SeaWorld-born killer whales suggest that newborn calves are about 2.6 m (8.5 ft.) long and 120 to 160 kg (265 - 353 lb.)
2. In the first few days after birth, the dorsal fin and tail flukes are flexible and pliable. They gradually stiffen.
3. The light areas of some young killer whales may be creamy white to pale yellow or tan rather than white. They usually turn white by the end of the first year, though some killer whales retain the yellowish color into adulthood.

Nursing

1. Most killer whale calves born at SeaWorld generally nurse for about a year, but may continue to nurse occasionally for as long as two years. This corresponds with observations in the wild.
2. Fat is an efficient source of energy to drive a calf’s high metabolism. Killer whale milk is very rich in fat.
   
   The fat content of killer whale milk fluctuates as the calf develops.
   
   High-fat milk is an adaptation for calves to be able to quickly build a thick, insulating layer of blubber.
3. A whale calf suckles from nipples concealed in abdominal mammary slits.
4. Calves nurse below water, close to the surface. The mother glides in a horizontal position with her tail arched, and the calf swims on its side with its mouth on the right or left mammary gland.
5. Killer whale calves observed at SeaWorld began nursing several hours after birth. First successful nursing attempts ranged from 1.8 to 29.3 hours after birth.
6. Calves nurse for about 5 to 10 seconds at a time, several times an hour, 24 hours a day. Nursing frequency peaks the first day or two following birth, at about 45 minutes total average nursing time. As a calf becomes more adept at nursing and obtains more milk at each feeding, nursing time decreases dramatically to 10 minutes per day or less after three weeks and to 5 minutes or less by 2 months.
7. At SeaWorld, it’s possible that first-time mothers may learn how to nurse their young by observing this behavior in other mother whales. Additionally, trainers teach them how to respond when their calf attempts to nurse.

Calf Development

1. Most calves grow about 64 cm (25 in.) during their first year, and they can gain about 400 kg (882 lb.)
   They grow about 53 cm (21 in.) during their second year.
To conserve energy, the calf swims in the slipstream of its mother.

**Births at SeaWorld**

1. Killer whales have been born at SeaWorld parks in San Diego, San Antonio, and Orlando. SeaWorld’s killer whale breeding program is the most successful in the world.

   Studying SeaWorld’s killer whales, scientists have learned a great deal about killer whale reproductive biology and calf development. The data they’ve gathered from killer whale calves and their mothers could not have been obtained without close daily interaction and observation.

   In September 1985 a female killer whale calf was born at SeaWorld Orlando. The calf, named Kalina, thrived and reached adulthood. She is the first killer whale successfully bred, born, and raised in a zoological environment.

   In February 1993 at SeaWorld San Antonio, Kalina had a calf of her own—the first second-generation killer whale calf born in a zoological park.

   To date, more than 30 calves have been successfully born and raised throughout SeaWorld’s collection of killer whales.

2. SeaWorld experts have developed techniques for artificially inseminating killer whales. Artificial insemination (AI) occurs when semen that has been collected from a male is placed into a female’s reproductive tract.

   The first killer whale born as a result of artificial insemination was born at SeaWorld San Diego in September 2001. The male calf was named Nakai.

   SeaWorld experts developed an intrauterine insemination technique using specialized medical instruments. They also developed a methodology for the collection and storage of viable killer whale semen.

   Veterinarians monitored daily urine samples to track hormone levels in adult female killer whales. This, combined with ovarian ultrasound examination, indicated when a female was about to ovulate. This information helped experts pinpoint the best time to introduce the semen.

   AI successes at SeaWorld require collaboration from SeaWorld veterinarians, killer whale trainers, animal keepers, and laboratory specialists.

   A critical component of a successful breeding program is maintaining genetic variability. Without AI, this meant transporting whales by plane between the SeaWorld parks, pairing different females with males, and hoping for successful mating. With the development of AI, managing genetic diversity has become easier. Instead of transporting an adult whale, semen samples can be sent from one park to another.
Longevity & Causes of Death

Killer Whales
Longevity & Causes of Death

Longevity

1. No one knows for sure how long killer whales live.
2. Long-term studies will ultimately answer this question. By counting growth layers in teeth, scientists find that killer whales in the North Atlantic may live to 35 years. Studies are still refining this method of aging.
3. For unknown reasons, researchers suspect killer whale calf mortality within the first six months to be "very high.” In the Pacific Northwest, for example, 43% of all calves die in the first six months. In other killer whale populations, calf mortality may be as high as 50% during the first year.
4. The photo-identification of killer whales in the Pacific Northwest began in 1973 and provides one of the longest cetacean field studies ever.

When factored in at birth, the average life expectancy of southern and northern resident killer whales is about 29 years for females and 17 years for males.

If a killer whale survives the first six months, a female’s average life expectancy is 46 to 50 years and a male’s is 30 to 38 years.

5. Currently at SeaWorld, five killer whales are older than 30 with one being close to 50. While studies continue to define the average life span of killer whales in the wild, the most recent science suggests that the life spans of killer whales at SeaWorld are comparable to those in the wild.

6. With continued research, it is likely that differences in longevity will be found in killer whale populations around the world.

Aging Studies

1. At SeaWorld parks, animal trainers routinely take a variety of measurements - including length, girth, and fin height - of killer whales. For a whale born at SeaWorld, experts are able to relate these measurements to the known age of the whale. This information helps provide a baseline for growth studies on wild killer whales.

Diseases, Parasites and Predators

1. Killer whales and other whales develop stomach ulcers, skin diseases, tumors, heart disease, and respiratory disorders.
2. Hodgkin’s disease has been seen in killer whales and stranded killer whales have shown severe atherosclerosis of the coronary arteries.
3. Recently described disease conditions include Salmonellosis in a neonatal stranded calf and West Nile Virus in an adult. Endogenous retroviruses have also been documented within the killer whale genome. The significance of these viruses on the health of killer whale populations is yet unknown.
4. Killer whales suffer from viral, bacterial, and fungal infections.
5. Parases—including roundworms, tapeworms, and flukes—may affect a killer whale’s health. In most cases, parasite infestations alone are unlikely to debilitate otherwise healthy animals, but they may harm animals that are already weakened by other illnesses or injuries.
6. Killer whales in New Zealand have evidence of small, non-fatal cookiecutter shark bites in their skin.
7. Killer whales are a top predator. Healthy adult killer whales have no natural predators of note.

Stranding

1. A marine animal may strand if it is affected by a severe, debilitating illness or injury, or if it is too weak to swim or hunt for food.
2. Killer whales have stranded in Alaska due to rapidly receding tides.
3. On rare occasions, killer whales strand, individually or in groups (called mass stranding). Mass strandings of whales and dolphins are natural phenomena that are largely unexplained. In many cases, the stranded animals are ill.
4. SeaWorld has helped in the rescue of many types of cetaceans, including killer whales. SeaWorld aided killer whales trapped in Barnes Lake, Alaska, and was part of the team that helped “Springer”, an orphaned two-year-old found off Canada’s northern Vancouver Island in 2002. SeaWorld assisted the Dolfinarium in Holland with veterinary care and husbandry for an orphaned and hearing-impaired rescued juvenile killer whale.
Conservation & Research

Hunting

1. Killer whales have never been consistently exploited on a large-scale basis. They have been hunted on a small scale for their meat, hides, blubber, and internal organs (which are processed into fertilizer and used as bait).

Before 1981, nearly 6,000 killer whales were taken by Japanese, Norwegian, and Soviet whalers.

Small numbers of killer whales are legally subsistence-hunted by certain indigenous arctic tribes.

Views from the Past

1. Humans have observed killer whales for centuries. A killer whale image was found carved into a rock in northern Norway and is estimated to be some 9,000 years old, making it the earliest known depiction of a cetacean.

2. Some human cultures have long been fascinated by killer whales, but until recently their lives were shrouded in misinformation—in the past, this has led to the persecution of these whales.

3. A few cultures respected killer whales, yet much of the ancient world did not. During the first century A.D., a Roman scholar named Pliny the Elder wrote that killer whales "cannot be properly depicted or described except as an enormous mass of flesh armed with savage teeth".

4. In 1835, R. Hamilton wrote that the killer whale "...has the character of being exceedingly voracious and warlike. It devours an immense number of fishes of all sizes...when pressed by hunger, it is said to throw itself on every thing it meets with...".

5. Many in modern civilization still envisioned killer whales as terrifying threats to humans, with a 1973 United States Navy diving manual warning that killer whales "will attack human beings at every opportunity".

Confrontations with Fishermen

1. In some areas, killer whales feed in connection with fishing operations, “stealing” fish from the fishermen. They eat fish from commercial longlines in New Zealand, Alaska, and Brazil. In Brazil, observers reported that more than 50% of the daily swordfish catch may be eaten by killer whales, and that occasionally the whales eat the entire catch.

2. Some fishermen blame the destruction of millions of dollars of equipment and fish loss on killer whales, and on rare occasions some have taken to shooting killer whales. Recently, researchers have attempted to develop non-lethal killer whale deterrents, including acoustic harassment devices, electric currents,
sparker devices (emits a flash of light to startle whales), rubber bullets, bubble screens, chemicals such as lithium chloride ether (to induce nausea) and reducing the sounds caused by the fishing operations. None of these deterrents have been very effective.

3. Fishermen shooting killer whales is believed to be one of the contributing factors to the unusually high mortality experienced by one pod off Prince William Sound—whales known for their habit of taking black cod off long-lines.

Pollution

1. Both natural toxins and human-made toxins can harm killer whales.

2. Chemicals that are used on land enter waterways through runoff and eventually end up in the oceans as pollution.
   Industrial pollutants are introduced to the marine environment through mining operations, agriculture, pulp mills, and other coastal industrial development.
   Household and garden pesticides can enter waterways through sewers and storm drains.

3. Some pollutants enter the ocean food chain and become concentrated in the bodies of killer whales and other marine predators.
   Some of these pollutants (which may not be harmful in small quantities) are stored in an animal's body tissues after they are ingested. Prey animals that contain such toxins in their bodies pass the toxins on to animals higher in the food chain. Pollutants can become concentrated and reach dangerous levels in the bodies of large predators such as killer whales.

   Persistent organic pollutants (POPs) are a group of environmental pollutants that include PCBs (polychlorinated biphenyls), DDTs (dichlorodiphenyltrichloroethane) and PBDEs (Polybrominated diphenyl ethers) from flame retardants. When ingested, POPs are not metabolized or eliminated. These fat-soluble molecules accumulate in fats, such as blubber and only enter the bodies of killer whales through their diet. Use and production of PCBs and DDTs in the United States were banned in the 1970s, but these POPs continue to be widely used around the world and all POPs persist in the environment. POPs can reduce reproductive capability and may be one factor in the decline of the Southern Resident killer whale population.

   Scientists analyzed blubber biopsy samples from killer whales of the eastern North Pacific Ocean. Experts haven’t yet defined a “toxic threshold” of PCBs for killer whales, but they do know at what concentrations these pollutants adversely affect harbor seals. PCB concentrations in most of the killer whale blubber samples surpassed these dangerous levels.

   PCB concentration increases with age in male killer whales and in sexually immature females. On the other hand, reproductively active female killer whales showed lower PCB levels than did adult males or sexually immature females. A mother killer whale transfers PCBs to her calf as the calf develops and also through fat-rich milk as the calf nurses.

   Transient whales were more contaminated than resident whales, probably due to differences in diet. Marine mammals (the preferred prey of transient killer whales) have higher PCB levels than do fish (which make up the diet of resident whales.)

   Up to 1,000 new chemicals enter the environment every year, so many other understudied or unknown chemicals could be affecting marine life including polychlorinated paraffins (PCPs), polychlorinated naphthalenes (PCNs), polychlorinated terphenyls (PCTs), personal care products like shampoo and pharmaceuticals such as synthetic estrogens and steroids.

   Oil spills can have long-term effects on killer whale populations. Populations of a resident and a transient pod inhabiting Alaskan waters near the site of the 1989 Exxon Valdez oil spill experienced major declines in the year following the spill and have failed to recover to pre-spill. Oil spills especially threaten transient killer whale populations since they may hunt prey animals sickened by exposure to the spill. Killer whales may not be able to detect oil due to poor olfaction.

Limited Food Availability

1. A key reason that the endangered Southern Resident killer whale population has not recovered is likely due to declines in populations of their main prey, Chinook salmon (Oncorhynchus tshawytscha), from overfishing by humans and habitat destruction. Northern Residents have also recently experienced a higher mortality rate that is probably linked to a reduction in Chinook salmon availability.

Whale Watching

1. Whale watching expeditions bring people close to wild whales and help people learn about them. In
British Columbia and the state of Washington, killer whales are the most popular cetacean of commercial whale watching companies.

Tours to watch whales in the wild are increasing in popularity around the world.

2. Higher concentrations and closer proximity of boats can force whales away from their traditional habitats and reduce a killer whale’s echolocation abilities when hunting for prey.

3. The National Oceanic and Atmospheric Administration (NOAA) Fisheries has developed “Marine wildlife viewing guidelines” to protect marine animals. Among other recommendations, the guidelines instruct whale watchers to keep their distance. Impeding the whales’ right of way is not allowed. Chasing, harassing, touching, and feeding animals also are prohibited.

IUCN / The World Conservation Union

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

2. The IUCN’s Red List is a system for assessing an animal’s relative risk of extinction. Its goal is to categorize and raise global awareness of species that face a high risk of extinction. The killer whale is categorized as “data deficient.” There is inadequate information to make a direct, or indirect, assessment of the species risk of extinction based on its distribution and/or population status.

Legal Protection

1. The U.S. Marine Mammal Protection Act (MMPA) of 1972 made it illegal to hunt or harass marine mammals in the U.S.

   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.

   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).

   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. The Endangered Species Act of 1973 (ESA) conserves endangered species and their ecosystems. A species is considered endangered if it is in danger of extinction.

   As defined in the ESA, a protected “species” may be a species, a subspecies, or a distinct population segment (DPS).

   In 2005, the Southern Resident killer whales of the eastern Pacific Ocean were listed as an endangered DPS under the ESA. The population was estimated at 200 whales in the late 1800s and currently stands at about 85 whales. This DPS faces risks including vessel traffic, toxic chemicals and competition for food, especially salmon. The small DPS is also susceptible to potential catastrophic risks, such as disease or oil spills.

   NOAA Fisheries and the U.S. Fish and Wildlife Service (USFWS) share responsibility for implementing the ESA.

3. The Convention in International Trade of Endangered Species (CITES) is an international treaty developed in 1973 to regulate trade in certain wildlife species. Killer whales are listed under CITES Appendix II: species that are not necessarily now threatened with extinction, but that may become so unless trade is closely controlled.
Research

1. The non-profit SeaWorld & Busch Gardens Conservation Fund works on behalf of wildlife and habitats worldwide. The goal of the Fund is to encourage sustainable solutions by supporting critical conservation initiatives worldwide.

The SeaWorld & Busch Gardens Conservation Fund supported a study on killer whale energetics to help determine how whales have solved the complex bioenergetic relationships of energy intake and expenditure and what impact they are eventually having on their system. The study measured the metabolic rates of killer whales at SeaWorld. This data was then used to estimate energy needs of the whales in the wild.

By assessing the metabolic rate of captive killer whales and relating it to heart rate, the study can be used to evaluate metabolic expenditures of free-ranging whales and ultimately apply this information to the conservation and protection of wild whales, such as the endangered population of Southern Resident killer whales.

2. Scientists all over the world continue to study the abundance, biology, reproduction, migration, and behavior of killer whales.

Marine Zoological Parks

1. SeaWorld trainers and veterinarians perform regular health exams on the killer whales to monitor and maintain their health.

Every two to four weeks trainers take body measurements on each whale, including body length; girth at several points; and dimensions of the flippers, flukes, and dorsal fin.
Killer whales are trained to present their tail flukes for blood samples to be taken.

Killer whales are trained to hold still and remain calm throughout procedures such as obtaining sonogram data.

Several times a day, a killer whale at SeaWorld can have its teeth cleaned and flushed with a water pic.

2. In the protected environment of a marine zoological park, scientists can examine aspects of killer whale biology that are different or impossible to study in the wild.

3. The unique opportunity to observe and learn directly from live animals increases the body of scientific knowledge and enhances public awareness and appreciation for wildlife.

Up until the 1970s, killer whales were mainly regarded as a nuisance animal. Attitudes began to change dramatically, mainly due to displays at marine life parks that allowed people to learn about and appreciate killer whales like never before. Killer whales provide the opportunity for zoological parks and aquariums to play a unique and unrivaled role in marine mammal education and conservation. Educational shows and programs at marine life parks can make a difference.

Independent studies have concluded that guests viewing dolphin shows demonstrated an increase in conservation-related knowledge, attitudes and behavioral intentions immediately following their experience.

Sweeney’s 2009 study aimed to better understand learning in zoological settings, particularly learning about marine mammals through interaction programs.

Her research concluded that all participants gained new knowledge within three broad categories: (a) dolphin physiology and natural history, (b) care and training of dolphins, and (c) conservation.
All participants in the study constructed personal meanings by connecting the activity to experiences, beliefs, and practices outside the interaction context. Almost all participants made associations with conservation.

Most participants shifted their attitudes and gained a sense of personal agency about beginning or increasing stewardship actions.

Visitors learned interspecies etiquette skills and trainers learned skills in dolphin training and management, people management, and teaching.

Visitors maintained long-lasting memories of the experience that occurred eight months to 18 years in the past.

Studies like these confirm the results of a Harris Interactive® poll the Alliance commissioned in 2005.

The Harris poll found that the public is nearly unanimous (95%) in its acclaim for the educational impact of marine life parks, zoos and aquariums. In addition, 96% of respondents agree that these facilities provide people with valuable information about the importance of our oceans and the animals that live there.

In April 2010, the journal Nature published an article citing evidence that most of what the general public knows about science is learned outside of a school classroom through visits to places like zoos and museums, websites, and magazine articles.

Killer whales spend much of their time underwater, making it difficult to observe and quantify certain aspects of their lives. Studying killer whale nursing behaviors in the wild, for example, would require either close, limited observations from a vessel or underwater viewing by humans, either of which would likely cause stress or alterations to the behaviors under investigation. Observing cetaceans in marine life parks allow for long-term, fine-scale studies that would be difficult to achieve in the wild. Analysis of sleep and resting patterns, echolocation abilities, vocal development and communication, reproduction, artificial insemination and calf birth, growth and development are examples of the detailed studies done on killer whales at marine life parks. Such studies add to our overall knowledge of cetaceans and supplements fragmented information from observations in the wild.

Millions of people have visited SeaWorld since the first park opened in 1964, and these visits have played a role in developing a sense of respect for wildlife, especially killer whales, and cultivating a sense of environmental stewardship.
Killer Whales

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