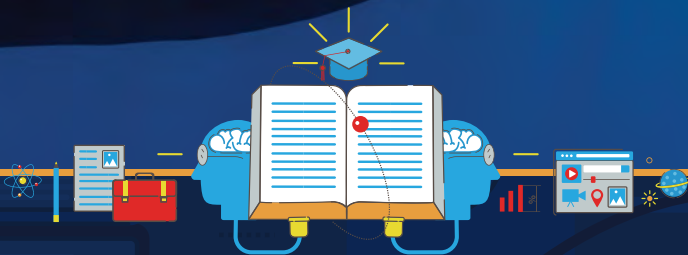
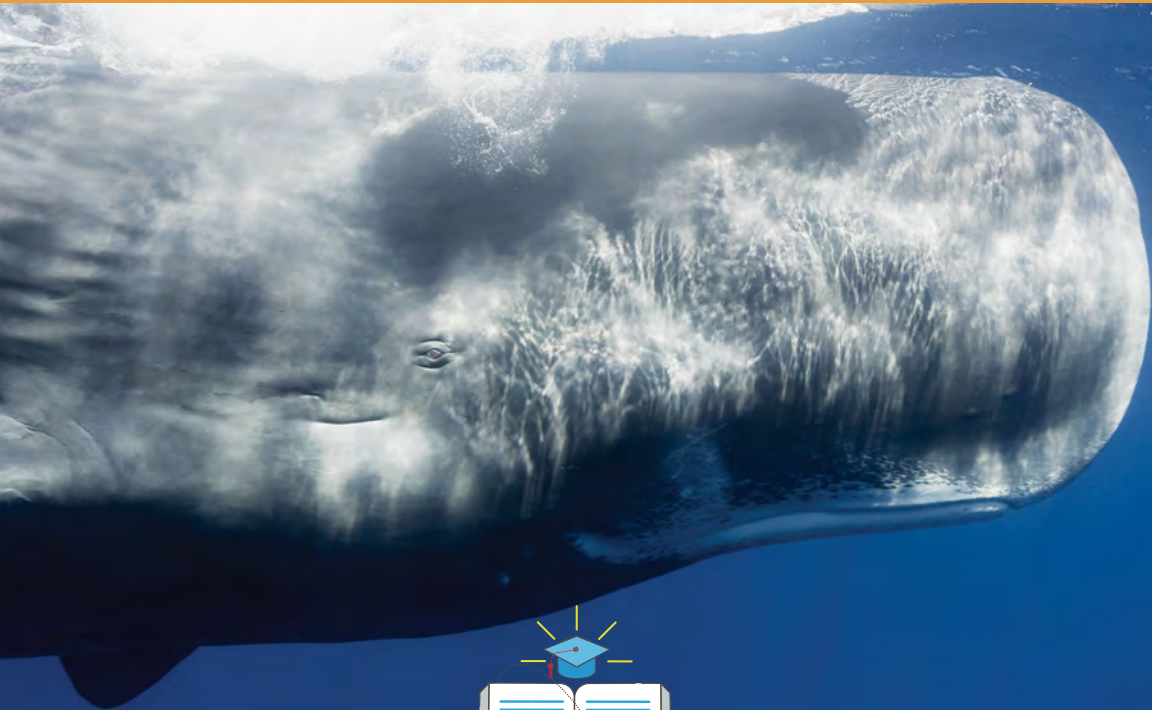


MASTERS OF THE DEEP: SPERM WHALES

A SCIENCE · 3D ADVENTURE

GRADE 5



By MIKE HEITHAUS, Ph.D.

symbioeducation™



KEY WORDS

Look for these words and try to figure out their meaning.

BALEEN

BIOLUMINESCENCE

CETACEANS

CONSUMER

DECOMPOSER

ECHOLOCATION

ENERGY

EXTINCT

HYDROPHONE

MAMMAL

MATTER

NUTRIENTS

PHOTOSYNTHESIS

PHYTOPLANKTON

PRODUCER

SCAVENGER

SEAMOUNTS

WARM-BLOODED



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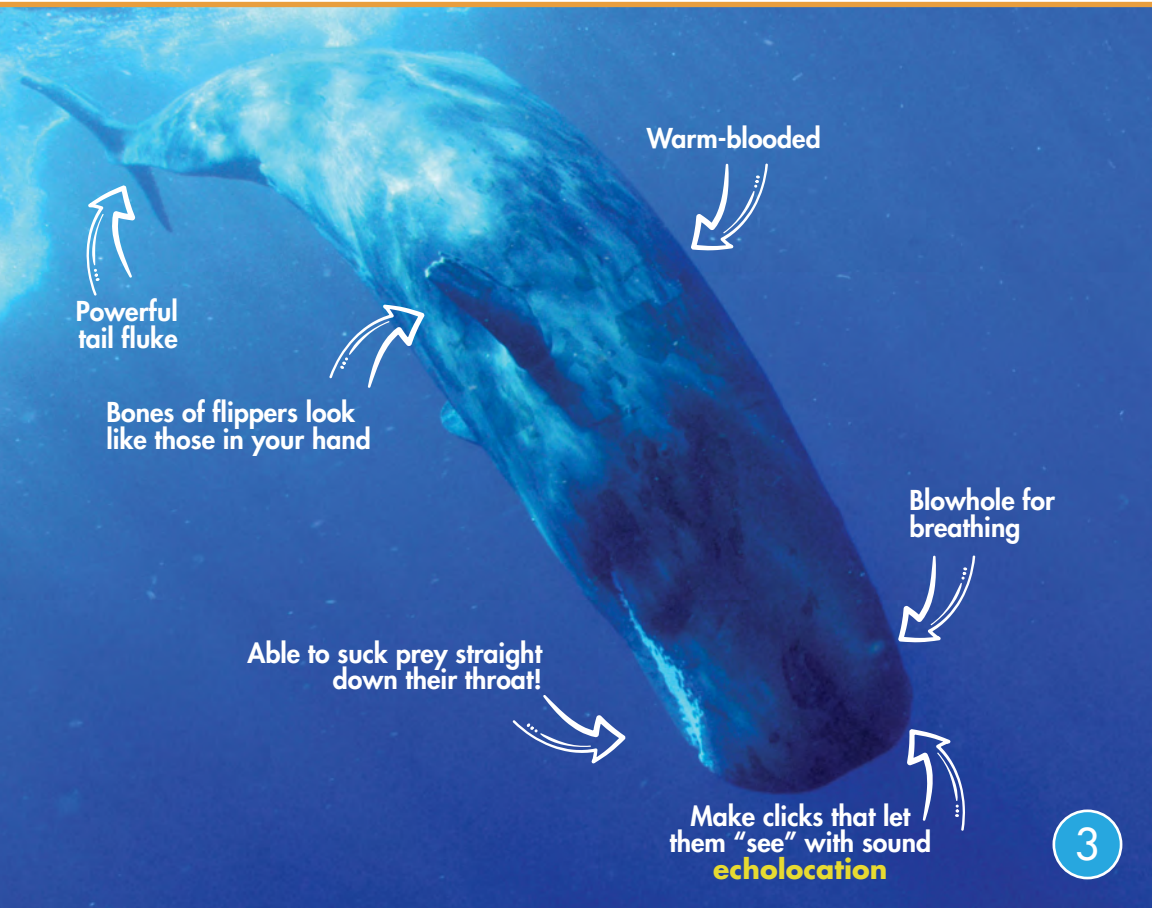


INTRODUCTION

Imagine if you could hold your breath underwater for two hours and dive deeper than two kilometers (that's more than a mile). Imagine if you could use sound to "see" in the never-ending darkness of the deep ocean. Imagine battling with a giant squid... and winning!



These may seem like superpowers for a human. But for a sperm whale, these experiences are just a part of everyday life.

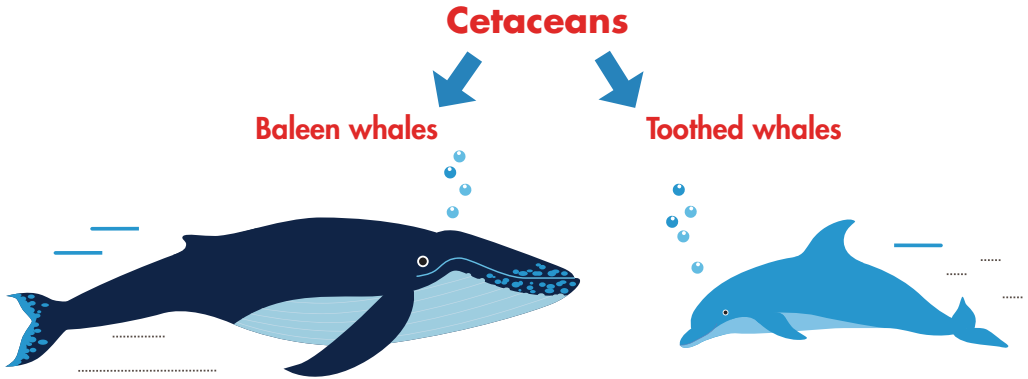




WHAT IS A SPERM WHALE?

Sperm whales may live in the water, but they are not fish. They breathe air and are **warm-blooded**. They are born alive in the water and they drink milk as babies. What kind of animal do you think they are? If you said **mammals**, you are right!

Whales and dolphins are part of a group called “**cetaceans**.” There are two major branches of the cetacean family tree. The first branch is the “**baleen** whales.” Humpback whales and blue whales are part of this group. These whales don’t have teeth. Instead, they have plates in their top jaw, called baleen, that are made of the same material as your fingernails. They use their baleen plates to trap shrimp-like creatures or small fish.



The second group of cetaceans is the “toothed whales.” Sperm whales and dolphins are toothed whales. Most toothed whales eat fish and squid. But some toothed whales, like killer whales, eat bigger prey like seals, sharks, and dolphins.



A group of humpback whales feed on herring in Alaska. Baleen whales have baleen plates in their upper jaws. They consume many prey in one giant mouthful.

All whales and dolphins evolved, or developed over time, from a land animal. It started more than 50 million years ago. Over the ages, each species became better adapted to life in the water. The first species on the path to today's whales waded, or walked, through the water. Later species had legs that helped them paddle. Eventually, ancient whale species used tail flukes to swim and could live their entire lives in the water. Finally, hind limbs disappeared. Scientists figured this out by looking at the fossil bones of ancient land mammals, ancient whales, and today's whales and dolphins.



Pakicetus



Ambulocetus



Dorudon

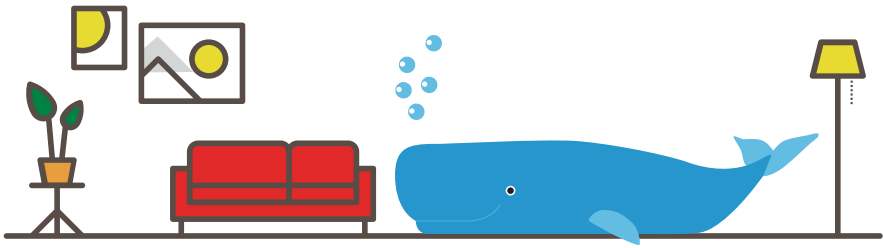


Today's
whales & dolphins

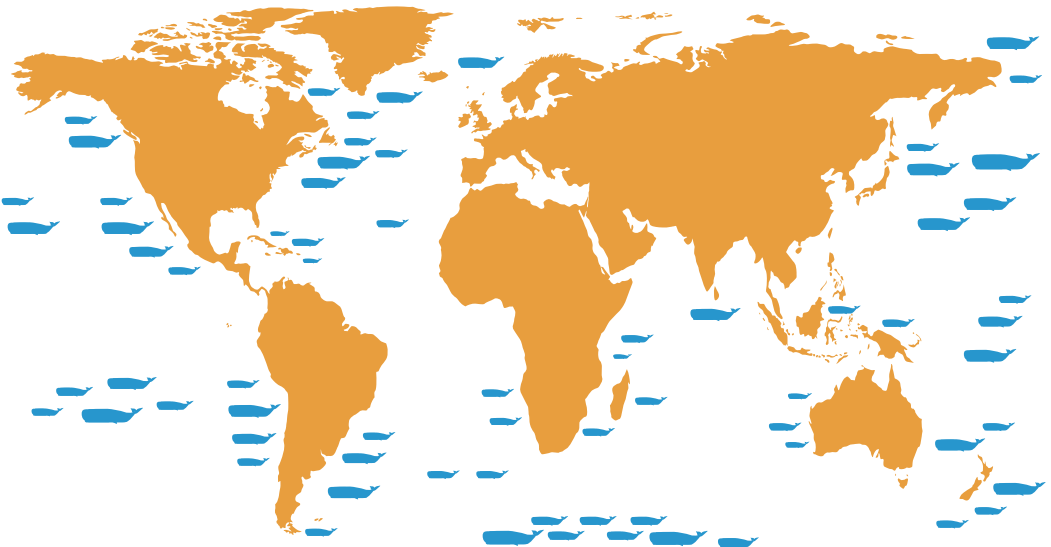


WHERE DO SPERM WHALES LIVE?

Sperm whales live all over the world. They can be spotted in cold waters when there is a lot of food there. Some sperm whales live in warmer waters near the equator all year long. Do you think it would be easy to see a sperm whale? It's not! They live in waters that are very deep and spend almost all of their time far below the surface of the water. Because they like deep water, sperm whales usually do not come close to the shore. But, in a few special places where the waters get very deep very quickly, they can be found close to shore. These areas are great places for scientists to study sperm whales!



Sperm whales are found in oceans all over the world.



THE WORLD'S LARGEST TOOTHED PREDATOR

Sperm whales are the largest predators with teeth in the world. Male sperm whales can grow to 18 meters (60 feet) and weigh more than ten elephants. Females are a little smaller. They grow to 11 meters (35 feet).

Because they are warm-blooded and have big bodies, sperm whales have to eat a lot of food. They mostly eat fish and squid; their favorite is squid. When they get a chance, they will even try to eat giant squid.

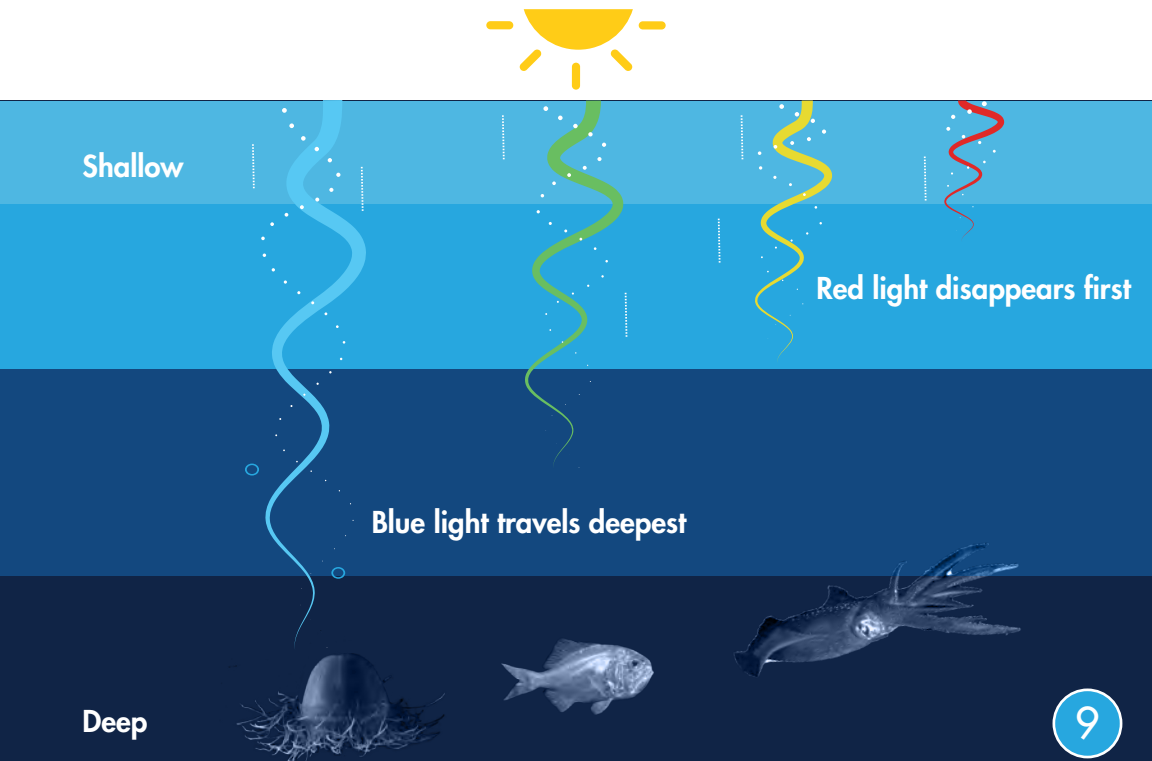
To catch their favorite prey, sperm whales have to dive deep underwater. It is cold and dark where they search for food. Sometimes they dive almost two kilometers underwater. For a sperm whale, this is not too hard. They can hold their breath for more than an hour. That is plenty of time to find and catch their prey. In fact, they can catch multiple prey during one dive. After a long dive, they rest at the surface to warm up and catch their breath.



LIFE IN THE DEEP

Most ocean animals that people think about live in shallow water or near the surface. But there are many organisms that live deep underwater where there is no sunlight. Why is there no sunlight? Light travels as a wave. When light hits an object, it can go through it, be absorbed, or bounce back. By the time you go deep underwater, all of the sunlight has been absorbed or scattered.

The color of an organism is the same as the color of light it reflects. A green plant reflects green light and absorbs other colors. As light travels through water, different colors are scattered or absorbed at different distances underwater. Red is the first color to be absorbed. That is why many small deep-sea organisms are red when they are seen in full sunlight. Their bodies reflect red light. Because red light doesn't reach the deep sea, the animals that live there don't reflect any light and are very hard to see. Scientists think that many deep-sea organisms can't even see the color red.



Like all organisms, deep-sea organisms need **energy** to survive. In most ecosystems the energy comes from the sun. **Producers**, like plants, convert the energy from the sun into stored energy using a process called **photosynthesis**. They use **nutrients** and other **matter** they get from their environment to build their bodies. In the open ocean, microorganisms called **phytoplankton** are producers. They are the base of the food web. This means they do not have prey. Phytoplankton can only live where there is plenty of energy from sunlight. For their populations to grow, they need plenty of nutrients to build their bodies. The energy in the deep sea starts with producers near the surface.

There isn't a lot of food for **consumers** in the deep sea. The food and energy in the deep sea mostly come from organisms like phytoplankton, fish, or even whales that die and sink. Deep sea organisms eat the whales as they fall to the bottom or after they land. These "whale falls" are an important source of energy and matter for many deep-sea organisms. Both **scavengers** (like hagfish, crabs and sixgill sharks) and **decomposers** (such as bacteria), depend on whale falls. Another way energy and matter get to the deep-sea is movement of organisms. Every night huge numbers of deep-sea organisms swim toward the surface to feed. Before daylight comes, these creatures swim back down to avoid being seen and eaten by predators.



There are many other challenges to living in the deep sea. For example, it is cold and dark, which can make it hard for organisms to survive. Many of the fish and squid that live in the deep sea might seem strange to us, but these creatures have adapted to survive in the dark, deep waters.

Some deep-sea organisms even make their own light, called **bioluminescence**. This prevents it from being pitch black in the deep sea, but it is still too dark to see well.

Dumbo octopus



Hatchefish



Pyrosome



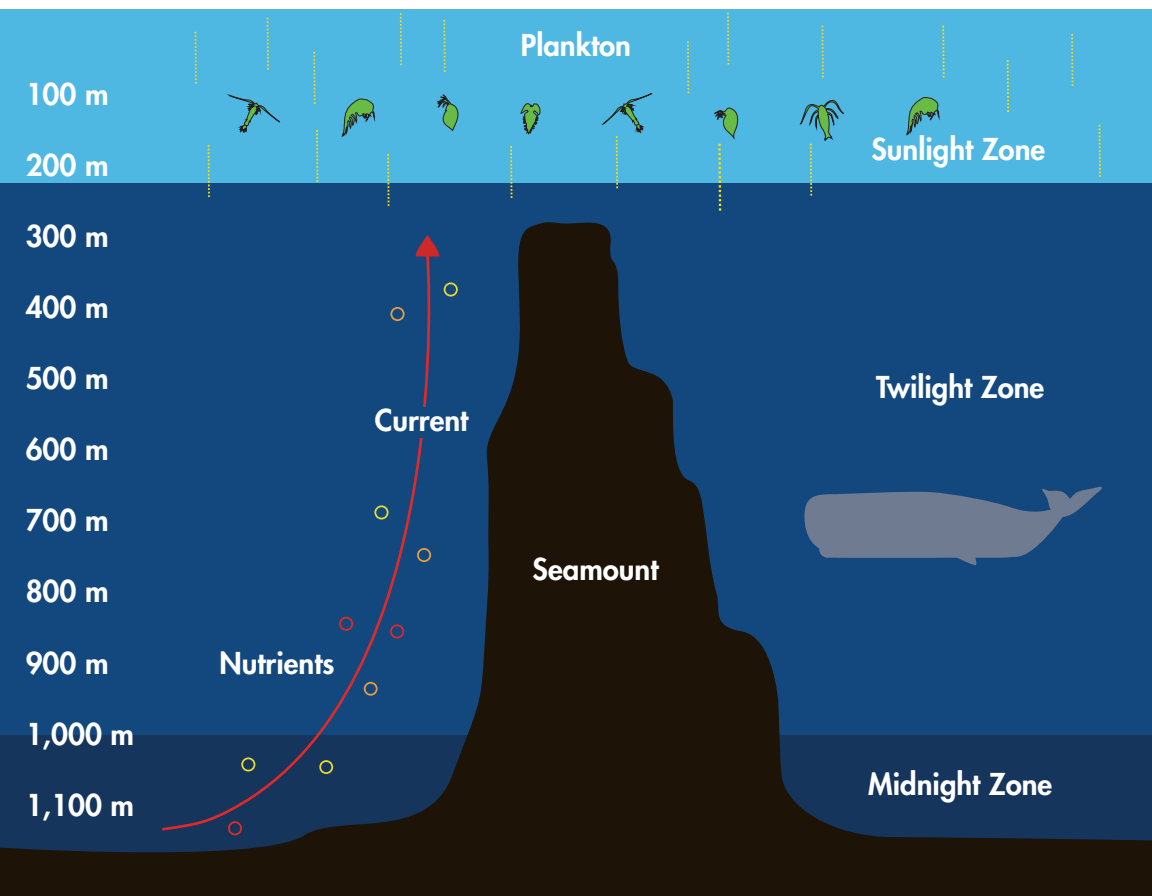
Anglerfish



There are many weird organisms in the deep sea. Some, like the anglerfish, have huge mouths so they can eat big prey. Some, like the pyrosome, glow with bioluminescence. Others, like a Dumbo octopus, have traits that help them hover in the water. Hatchefish have huge eyes that are extremely sensitive to the dim light from bioluminescence.

The waters near the surface of the open ocean often seem empty. This is because nutrients sink to the bottom, which keeps producer populations from growing. If there are not many producers, there is very little food for consumers, like fish.

Some places in the open ocean, however, do have a lot of life. Underwater mountains that don't break the surface are called **seamounts**. Deep-sea water currents carry nutrients, and when the currents hit the seamount they move up toward the surface. The currents move nutrients towards the sunlight, where producers can use it. There are a lot of nutrients near seamounts, so there is a lot of life near them.

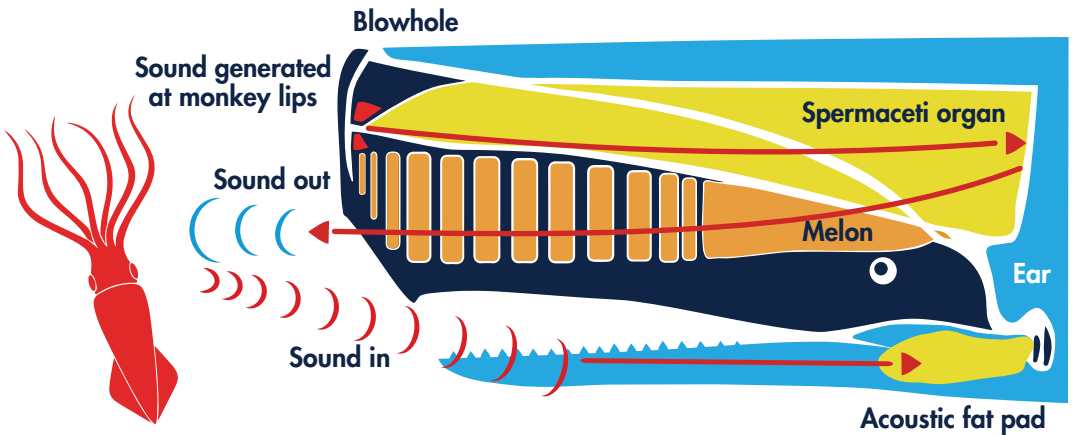


FINDING A MEAL

How do sperm whales find and catch their food in the dark? They can't use vision, so they use sounds called **echolocation**. Just like light, sound travels as a wave.

Sperm whales make clicks in their heads with a structure called the "monkey lips." The clicks travel out into the environment. When the sound hits an object, like a squid, it bounces back to the whale. The whale uses the clicks to know what the object looks like and how far away it is. It is like seeing with sound! Other animals use echolocation too. The most well known are bats and dolphins. Engineers have been inspired by these animals and developed sonar that uses sound in the same way. Sonar uses echoes to create a picture of the bottom of the ocean, fish, and other objects in the water.

SPERM WHALES USE ECHOLOCATION TO FIND PREY



Even if a sperm whale finds squid or fish, they can still be tough to catch. Squid can move quickly, and they are slippery. Sperm whales have around 20 peg-like teeth on each side of their lower jaw. These teeth fit into sockets on the upper jaw. This helps them clamp onto a slippery squid. When sperm whales open their mouths quickly, water and prey get sucked in. Sometimes they can suck their prey straight into their throat without having to bite it first!



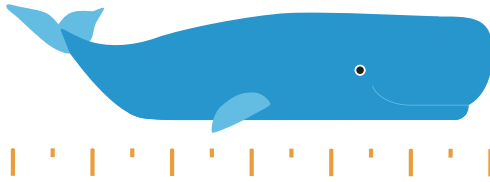
40 TEETH

Sperm whales have about 40 teeth in their lower jaw. These teeth fit into sockets in the upper jaw. This helps them grab giant squid.

GROWING UP SPERM WHALE

A baby sperm whale is called a calf. Sperm whales give birth to one calf at a time. Their babies are huge! They are four meters (13 feet) long and weigh 1,000 kilograms (2,200 pounds) when they are born. Calves depend on their mothers for a long time. Most calves nurse, or get milk, for two to four years. But, scientists have found a 13-year-old whale still nursing from its mother!

Baby whales can't hold their breath for very long. That means they can't go with their mothers when they eat. But baby whales aren't left to fend for themselves. Other whales act like babysitters, and stay with them at the surface until the mothers get back. While the mothers are gone, the babies like to play.



HUGE AT BIRTH!

4 METERS LONG
1,000 KILOGRAMS

SPERM WHALE LIVES

Sperm whales can live to be 70 years old. Females live in the same family groups for their whole lives. These groups are led by an old female. Female groups stay in warmer waters all year. Food in these warm waters can be hard to find. Whales need to keep moving to find the places where they can hunt before the prey move somewhere else. The oldest female whale uses her experience to help lead the group to places where they can find food.

Elephants live in groups similar to those of sperm whales. Why might this be? They face similar challenges. Sperm whales and elephants need to protect their young from predators. They also need to rely on older individuals' memories. Like sperm whales, elephants have long life spans. When it gets tough to find a meal, older sperm whales and elephants know where to find food. Elephants are also able to find water in different conditions. For instance, they know where the good water holes are during a drought.



Male sperm whales leave their family groups when they are about ten years old. Young males group together in warm waters. Adult males are so big that they can't find enough food in warmer waters all year long. In the summer they migrate toward the poles. They do this because there is a lot more food near the poles when the nutrient-rich water warms up. In the winter, the adult males move back to the tropical waters near the equator to find females.

LET'S CODA!



Sperm whales spend a lot of their time socializing with other whales. Sometimes they rub against each other. They may jump out of the water in a behavior called a breach. They also produce social sounds called codas. Each whale group has its own coda that may help individuals stay in touch when they spread apart to find food.



Sperm whales live in small family groups of females and calves. Adult males spend their summers in colder waters where there is lots of food. In the winter they travel to the tropics to find mates.

A killer whale!



Some types of killer whales only eat fish. Others prefer eating whales, seals, and sea lions. These mammal-eating whales are a big threat to sperm whales.

Sperm whales are protected today. They used to be hunted by people because the oil in their heads could be used for lamps. Before motors were invented, sperm whales were dangerous to hunt. The famous book *Moby Dick* is based on real events. A sperm whale rammed and sank a whaling ship! People killed so many sperm whales that they almost became **extinct**. Eventually, sperm whales and other whale species became protected from hunting. This helped their populations grow in many places. Unfortunately whales still aren't completely safe.

Sometimes whales get tangled in nets or are hit by ships. Some whales eat plastic bags that they might think is a squid or jellyfish. These plastic bags can kill whales. Can you think of a way that you might be able to help keep sperm whales safe from this threat?

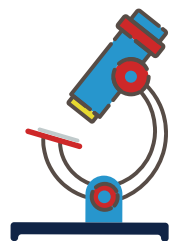
When sperm whales get sick, they sometimes swim into shallow water and get stranded on the beach. Because the whales have such close family groups, other members of the group swim into shallow waters with them. Then the entire group gets stuck on the beach. When this happens, people try to help the healthy animals get back to deeper water.



Not long ago scientists learned most of what we know about sperm whales from ones that washed ashore. Now there are many ways to study them when they are in their natural habitat.

STUDYING SPERM WHALES

How have we learned so much about sperm whales? How will we find out more about them? Some scientists live on ships to watch sperm whales every day for months at a time. Scientists take pictures of the flukes of whales when they lift them out of the water. Like a fingerprint, scientists can tell individuals apart using marks on their tails and bodies. By naming each whale and following them for many years, scientists learn about their lives. To learn about the sounds sperm whales make, scientists use special underwater microphones called **hydrophones**.

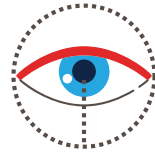


Pieces of sperm whale skin fall off of their bodies regularly. Scientists can learn a lot from this skin or from small samples of blubber. They can look at genes to tell how animals are related. They can see if there are dangerous chemicals in their bodies from pollution.



In the past, it was a challenge for scientists to study sperm whales when they were deep underwater. Engineers were a big help! They designed sonars that worked like echolocation. Sonars helped them study the squid and fish in the deep sea. Other engineers designed tags that could attach to whales with suction cups. These tags provide information on the temperatures and depths of where the whales swim. Some tags can record sound and have tracking devices that use satellites to identify the whales' location wherever they swim. The newest tags even have cameras.

There are still many mysteries to solve about sperm whales. Now that you have learned a lot about them, you are ready to join a research team on a mission!





Dr. Mike Heithaus attaches a camera to a whale with a suction cup. The suction cup does not hurt the whale. It stays attached to the whale for several hours or more. When it falls off, it floats to the surface. Scientists use radio tracking devices to find the camera. Then they can see what the whales have been doing - maybe even battling a giant squid!



GLOSSARY

BALEEN

a series of plates found in the upper jaw of baleen whales; made of keratin, which also makes up fingernails and hair

BIOLUMINESCENCE

light emitted by organisms

CETACEANS

the group of mammals that includes whales, dolphins, and porpoises

CONSUMER

an organism that feeds on plants or animals for energy

DECOMPOSER

an organism that feeds on and breaks down organic material

ECHOLOCATION

the use of reflected sound to locate objects

ENERGY

the capacity of a physical system to perform work

EXTINCT

a species or group of organisms no longer in existence

HYDROPHONE

a microphone that detects sound waves underwater

MAMMAL

a warm-blooded vertebrate distinguished by hair or fur, presence of milk in females, and (typically) the birth of live young

MATTER

something that takes up space and has mass

NUTRIENTS

substances that provide nourishment essential for growth and life

PHOTOSYNTHESIS

the process that producers use to convert sunlight, water, and carbon dioxide into sugars and oxygen

PHYTOPLANKTON

small or microscopic plants floating in the water

PRODUCER

an organism (like a plant) that uses photosynthesis or another process to make its own food

SCAVENGER

an animal that feeds on dead animals

SEAMOUNTS

underwater mountains

WARM-BLOODED

an animal that can generate its own heat and maintain a constant body temperature



PHOTO CREDITS

Abbreviation Key: SS = Shutterstock.com; NOAA = National Oceanic and Atmospheric Administration

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SCIENCE·3D

Thanks for learning about sperm whales with us. Our science adventures take us around the world to uncover secrets of the most amazing animals and places. Our mission and passion are to share these scientific discoveries with you. There are so many cool things to see out there, even in your own backyard, so get outside and explore!

MIKE HEITHAUS, Ph.D.

Dr. Mike Heithaus is an explorer, author, educator, and television host. He is a professor of biology and Dean of the College of Arts, Sciences & Education at Florida International University. Mike and his students study sharks, whales, sea turtles, and other large marine animals around the world. They also work to help protect these species. Mike loves sharing his work with others. He has written textbooks and helped create programs for students in elementary, middle, and high school. He has been on television programs on PBS, National Geographic, and Discovery Channel's Shark Week.



PATRICK GREENE

As a wildlife filmmaker, Patrick has always had a passion for animals. He started to draw pictures of sharks and whales when he was just five years old. Later he went to college to become a marine biologist and learned a lot about science. Then he got a job in television and learned how to make videos too. Since then he's gone all over the world studying and filming wild animals. He has made shows for National Geographic, PBS, and ABC, and even won an Emmy Award. He loves making videos to teach students about science and about the many creatures that share our world.





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