

PART 1

How did blue whales get so big?

By Polly Shulman

“We live in the age of giants,” says Dr. Jeremy Goldbogen. He’s a marine biologist at Stanford University’s Hopkins Marine Station in Pacific Grove, California. The giants he’s talking about are blue whales. They are the largest animal that ever lived. They’re more massive than any dinosaur. They’re probably longer, too. An adult can weigh over 180,000 kilograms (400,000 pounds). That’s as much as 28 male African elephants. “For scientists and non-scientists alike, they’re incredible to see,” says Goldbogen. “Just watching them breathe and swim and dive underwater is absolutely awe-inspiring.” Titanosaurs are the largest land animals we know of. They may have been half the mass of blue whales. But titanosaurs have been extinct for more than 66 million years. The giants of the ocean are alive right now!



Figure 1. Giants of the sea. Blue whales are the largest animals that have ever lived.

Illustration by Alex Boersma

Being big has lots of advantages. It’s easier for big animals to avoid predators. It’s also easier to travel long distances. Whales have big tails

that they use to push themselves through the water. They migrate to find food and to reach their breeding grounds. A blue whale's most efficient swimming speed is 2 meters per second (4.5 mph). That speed doesn't use too much energy. At that speed a blue whale can cruise around and migrate long distances with very little effort. But when it needs to, it can also swim in bursts as fast as 48 kph (30 mph).

The larger an animal is, the more efficient its metabolism. That means large animals need relatively less energy to live and get things done. Animals lose heat from their surface (their skin). Larger animals have more skin (surface area) than smaller animals. But they have *way* bigger bodies (more volume). Compared to smaller animals, they lose relatively less heat through their skin. That lets them spend relatively less energy on staying warm.

With efficient metabolisms, blue whales can build up fat quickly. Having more fat lets them go without food for long periods. "A healthy whale is a fat whale," says Dr. Dave Cade. He's a postdoc in the Goldbogen lab. Blue whales eat a lot during the summer. Some blue whales can put on 50 percent of their body mass in blubber. They use it to swim long distances efficiently without pausing to eat. They migrate from their summer feeding grounds to their winter breeding grounds. That's where they have their babies. During the trip, they live on their summer blubber. This lifestyle wouldn't be possible without their enormous bulk.

And this enormous bulk wouldn't be possible without their watery home. The ocean provides plenty of space and food. Seawater supports the whales' weight. On land, gravity pulls animals down. They have to support their own weight. That stops them from growing so big. The bigger and heavier a land animal gets, the thicker its legs need to be. Thin legs would snap. But a blue whale floats without the stress of gravity.

Size comes with a cost, too. Shirel Kahane-Raport is a graduate student in the Goldbogen lab. "Survival becomes hard for giant animals," she says. "If you have a large body volume, you need to keep that body fed." Blue

whales need big mouths to get enough food. “They really put their money where their mouths are,” Kahane-Raport says. Compared to smaller whales, the front of blue whales’ bodies are surprisingly large. They have extra-massive skulls, jaws, and ventral pouches. Ventral pouches are the expandable body parts that they use to gulp their prey (**Fig. 3**).

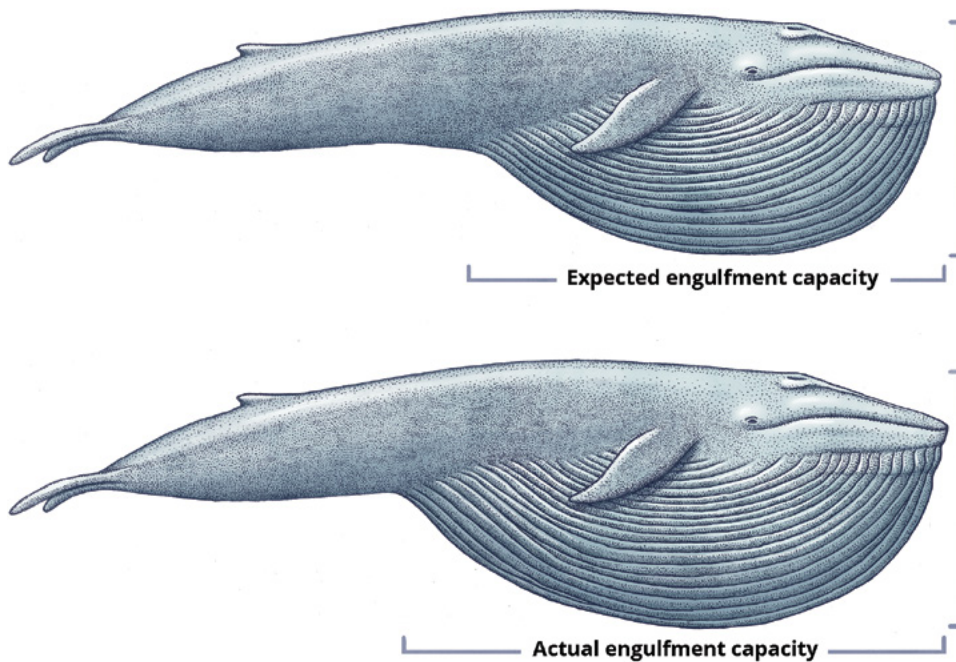


Figure 2. Surprisingly big pouch. Blue whales have evolved a gigantic gulp. The top picture shows how big their pouch would be if they were shaped like smaller whales. The bottom picture shows how big their pouch actually is compared to their length. Illustration by Alex Boersma

What Are Blue Whales, Anyway?

There are two kinds of whales: toothed and baleen (**Fig. 4**). Toothed whales are hunters. They target their prey one by one. They hunt for animals like fish and squid.

Baleen whales, on the other hand, feed in bulk. They eat large quantities of small organisms all at once. To do it, they use a material called baleen. Baleen is made of the same protein that makes up our hair and fingernails. In other animals it makes up hoofs, claws, horns, and beaks. In whales it takes the form of a curtain of bristly, comblike plates. They hang from the gumline of the whale’s upper jaw. The tough, flexible

baleen plates serve as a filter. They allow the whale to separate masses of prey animals from water or sand.

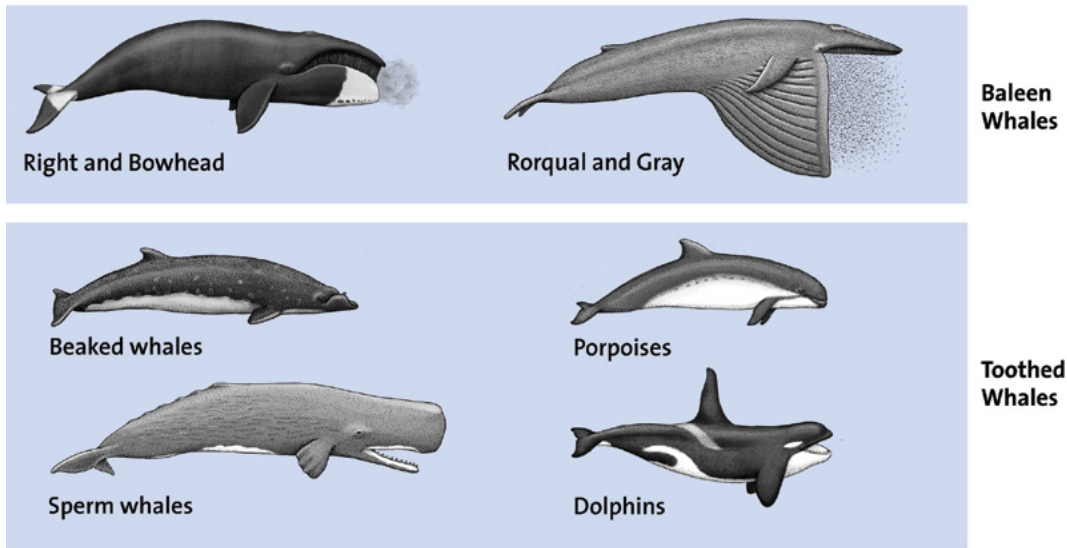


Figure 3. Whale family tree. Illustration by Alex Boersma

All baleen whales use their baleen to help them feed. Right whales, for example, will often swim near the surface with their mouths open. Water passes through the back of the mouth and food is trapped by the baleen.

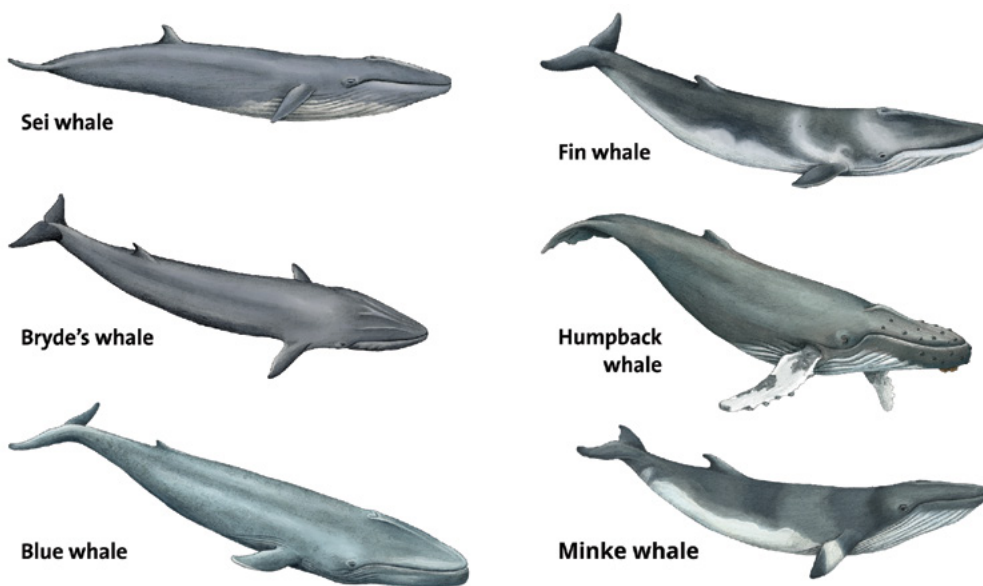


Figure 4. Rorqual whales. Six of the nine extant rorqual species are represented here. (Not pictured are Ormura's whale and two species of minke whales.) Illustration by Alex Boersma

Blue whales belong to a group called **rorquals**. This is the largest group of baleen whales. Rorquals that are alive today include blue, humpback, and fin whales, and six other species (**Fig. 5**). What makes a rorqual a rorqual? Its dramatic feeding technique—the big gulp. Folds of skin run from below the mouth back to the belly button. These folds allow the rorqual’s throat to expand immensely when it feeds. The throat sac opens up like a parachute. The rorqual takes in enormous volumes of food and water in a single mouthful.

A blue whale can engulf more than its own body mass of water in one gulp. Rorquals look for water with lots of prey in it. After they take mouthfuls of water and prey, they push out the water through their baleen plates. They use the thick, strong muscles in the area that stretches about halfway back along the undersides of their bodies. And they do it *fast*. In the case of blue whales, it takes less than 90 seconds! Pushing out the water collapses their throat pouches again. The big gulp gets them a huge amount of food. It gives the whales the energy they need to keep their gigantic bodies going.

Rorquals use vision to spot their prey. “We think that these whales actually use light to find their food, even in really deep environments,” says Cade. “Blue whales have giant eyes, just massive! They have great eyesight.” (The big eyes allow them to gather more light in the dark depths.)

Rorquals may use other senses as well, say the scientists. They may listen for sounds the plankton make. Or they may use whisker-like hairs on their chins to feel for food in the dark. “The theory here is that you basically swim around until the food hits you in the face,” says Cade. “Then you open your mouth and feed on the stuff.”

And memory is important too. A team of researchers found that rorquals return to spots where they’ve found lots of food in past years.

Baleen whales migrate vast distances to areas where their prey animals live. They migrate farther than any other mammals. They swim between their tropical breeding grounds and the cooler waters where they find

food. It's a very long trip! They need an immense amount of energy for these migrations. They have to get most of it by bulking up at their summer feeding grounds before starting out. And it's getting harder for them. Human activities such as shipping and fishing interfere with the whales' feeding and migrations.

Blue whales' massive body size and range bring challenges. First, the whales feed only on tiny shrimplike animals called krill. Krill are among the smallest organisms in the ocean. It takes a whole lot of krill to keep a giant blue whale going. Blue whales feed from around May to November. During that time, a blue whale must capture about 500 million krill a day!



Figure 5. Blowhole. Like all mammals, blue whales breathe air, not water. This one has come to the ocean's surface to take a breath through its blowholes. Those are like our nostrils.

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Another challenge is breathing. Fish can breathe in water, but whales are mammals like us. They breathe air. They need to come to the surface to take a breath. But their prey animals live deep underwater. So whales have to hold their breath for a long time when they dive for food—sometimes more than 15 minutes!

As much as we know about blue whales, there is much more left to learn. These marine giants are hard to study. They live in a separate world from ours. But unlike the massive dinosaurs, they are alive *now*. Because we happen to be living at the same time, says Goldbogen, “we have a unique opportunity to study how those animals function at the upper extreme of body mass. How do they interact with our environment? How can we protect these species? How can we ensure that they can persist for future generations?”

Stop and Think

1. Why is it important to understand the feeding behavior of blue whales?
2. If you wanted to know what a whale does underwater, what kind of data would you need to collect?
3. How would you collect it?