

Voyager

The world of all ages

SHARKS

A SHARK IS A VERY SPECIAL FISH. SHARKS ARE EXPERTS AT CATCHING FOOD AND SURVIVING TOUGH TIMES. THEY'VE BEEN AROUND FOR MORE THAN 400 MILLION YEARS, MUCH LONGER THAN PEOPLE, AND EVEN DINOSAURS.

TODAY THERE ARE MORE THAN 350 SPECIES OF SHARKS LIVING IN OCEANS AROUND THE WORLD.

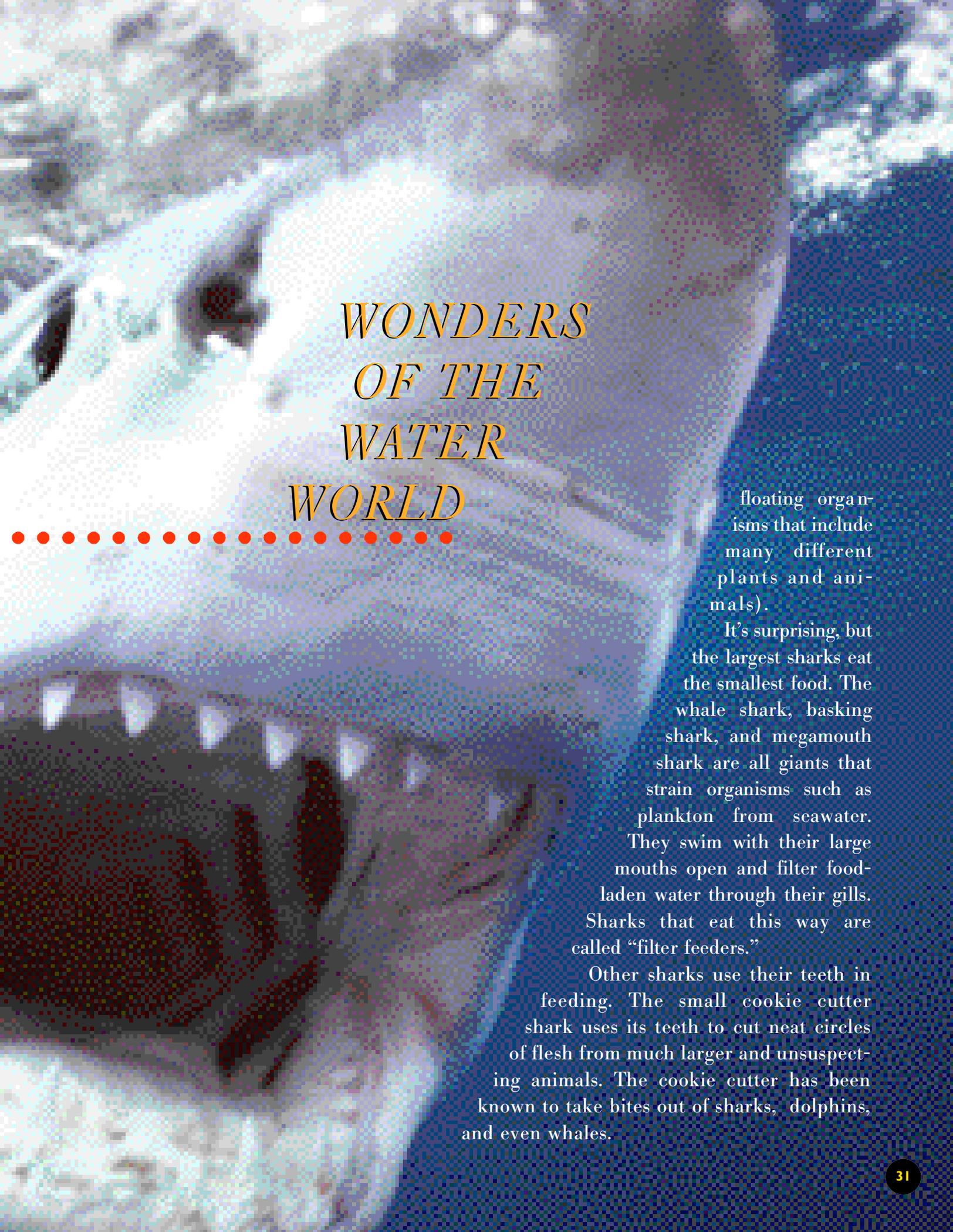
BY MEMORIE YASUDA

Built for Survival

Sharks come in a variety of sizes. The largest is the whale shark, a whopper of a shark that can grow to 60 feet in length. That's almost the size of a bus! The smallest shark is the dwarf lantern shark, it is only six to seven inches long.

Most fish have calcified bones, similar to human bones. But 400 million years ago, a few fish, including the ancestors of modern sharks, lost bones that were then replaced with a calcified cartilage skeleton. Cartilage is the flexible material that forms the end of your nose and ears. Its strength, flexibility, and light weight gave sharks advantages in the competition for life in the ocean.

Sharks are carnivorous and will eat things such as fish, including other sharks, as well as mammals, crustaceans, and plankton (small



WONDERS OF THE WATER WORLD

floating organisms that include many different plants and animals).

It's surprising, but the largest sharks eat the smallest food. The whale shark, basking shark, and megamouth shark are all giants that strain organisms such as plankton from seawater. They swim with their large mouths open and filter food-laden water through their gills. Sharks that eat this way are called "filter feeders."

Other sharks use their teeth in feeding. The small cookie cutter shark uses its teeth to cut neat circles of flesh from much larger and unsuspecting animals. The cookie cutter has been known to take bites out of sharks, dolphins, and even whales.

Sharks have lots of teeth and can replace them very quickly. They can have five to 20 rows of teeth—as many as 3,000 in all. They can replace lost teeth within days. That’s because sharks have extra teeth ready to go behind the ones they are already using. Some sharks go through 50,000 of them in a lifetime!

Lean, Mean Swimming Machines

Some sharks can chase down many of the fastest fish. The fastest shark, the shortfin mako, can swim 20 miles per hour. That’s very fast considering how much harder it is to move forward in water than in air. The body design and overall torpedo shape of sharks make them extremely efficient swimmers.

Part of the difficulty for humans in swimming is moving forward while keeping from sinking; the less energy used to stay afloat, or buoyant, the more energy is available to swim ahead. When an object is neutrally buoyant, its density is neither more nor less than seawater. So it neither sinks nor rises once it’s suspended in the water.

To be neutrally buoyant, sharks use the oil in their livers. But few sharks are completely neutrally buoyant because that would require having a very large liver. Such an enlarged liver would change their streamlined body outline and interfere with their swimming. The oil in a shark’s liver does allow it to swim at various depths of water—something that is difficult for bony fishes, which use gas for buoyancy.

Sharks have small, hard scales called “dermal denticles” that give them a smooth appearance instead of scaly, fish-like skin. Denticles are made like teeth. The outer layer of the denticle is enamel, and there is an inner pulp cavity. They have a special shape that smooths the flow of water around the shark’s body. This allows sharks to swim quickly and stealthily with little disturbance to the surrounding water.

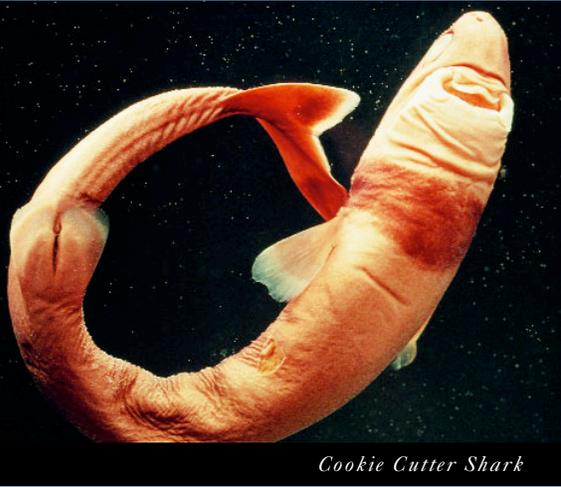
The torpedo-shaped mako is considered the rocket of the shark world. Scripps scientists Jeanine Donley and Robert Shadwick wanted to know why. They knew that the shapes of two fast fish—the mako shark and tuna—were similar. While observing makos swimming in the laboratory, the scientists discovered that the tuna and the shark both swim in a similar and unusual way.

Whale Shark

Great White Shark

Megamouth Shark





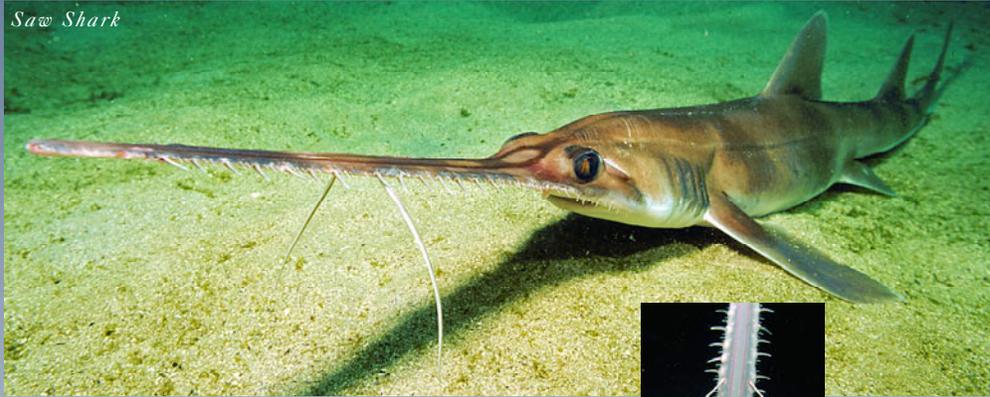
Cookie Cutter Shark



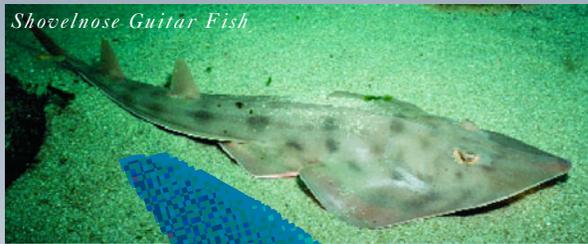
Mako Shark



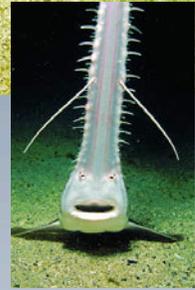
Wobbegong Shark



Saw Shark

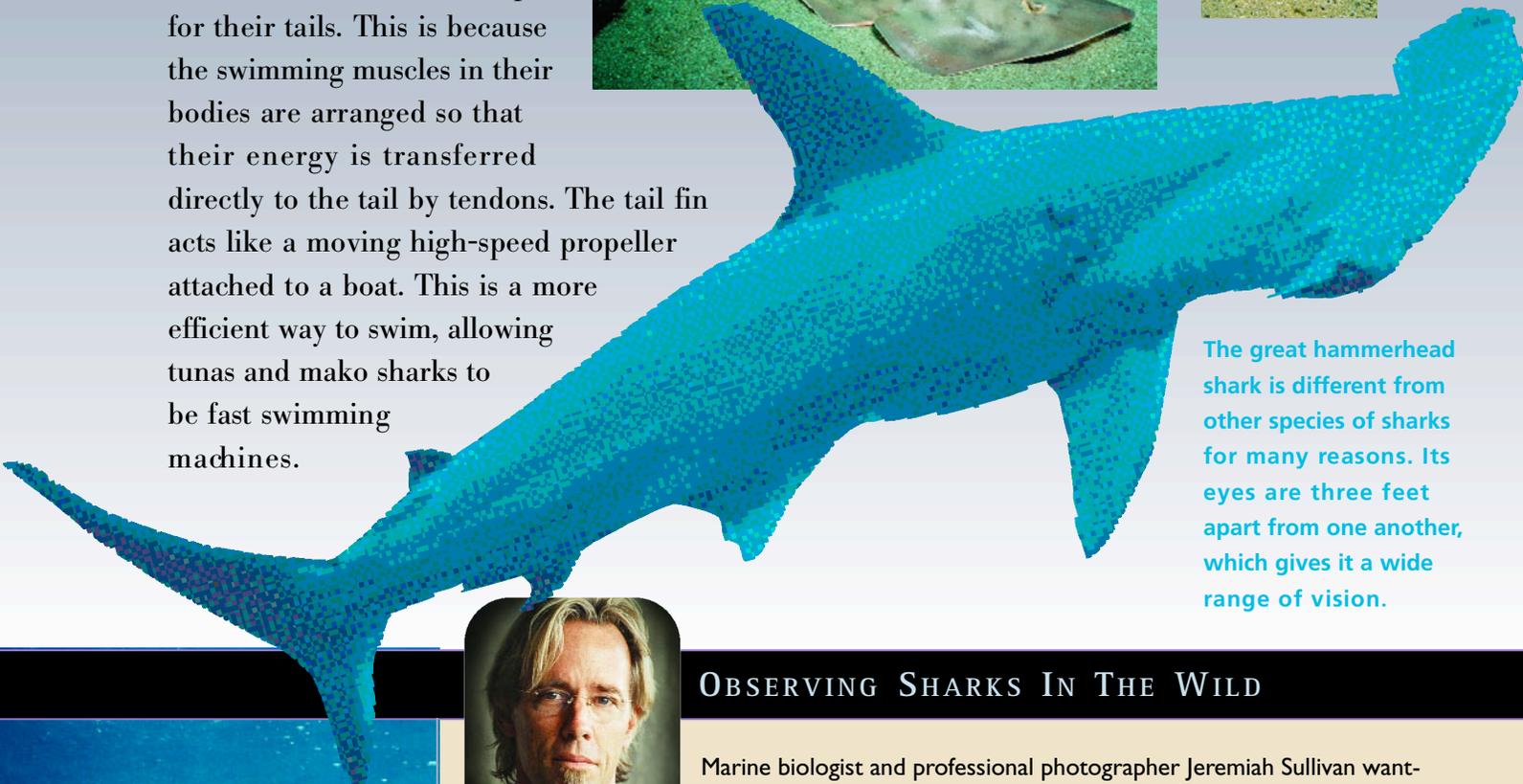


Shovelnose Guitar Fish



When most fish swim, a wave passes down through their bodies as the muscles contract. When the mako and tuna swim, they don't wiggle much of their bodies except for their tails. This is because the swimming muscles in their bodies are arranged so that their energy is transferred directly to the tail by tendons. The tail fin acts like a moving high-speed propeller attached to a boat. This is a more efficient way to swim, allowing tunas and mako sharks to be fast swimming machines.

The great hammerhead shark is different from other species of sharks for many reasons. Its eyes are three feet apart from one another, which gives it a wide range of vision.



OBSERVING SHARKS IN THE WILD



Marine biologist and professional photographer Jeremiah Sullivan wanted to swim with the sharks to get to know them better. He found that watching them from inside protective shark cages was inconvenient. So he has been working on creating a special protective shark suit.

The smooth, efficient shark scales called "denticles" are the inspiration for the suit's design. "Over the years I have built shark suits from many kinds of materials—steel mesh, armor plates, high-tech fabrics, and so forth," Sullivan said. "I am in the process of designing what I believe will be the final perfect shark suit, one constructed primarily of titanium, a very light but strong metal used to construct racing bicycles and other high-tech products."

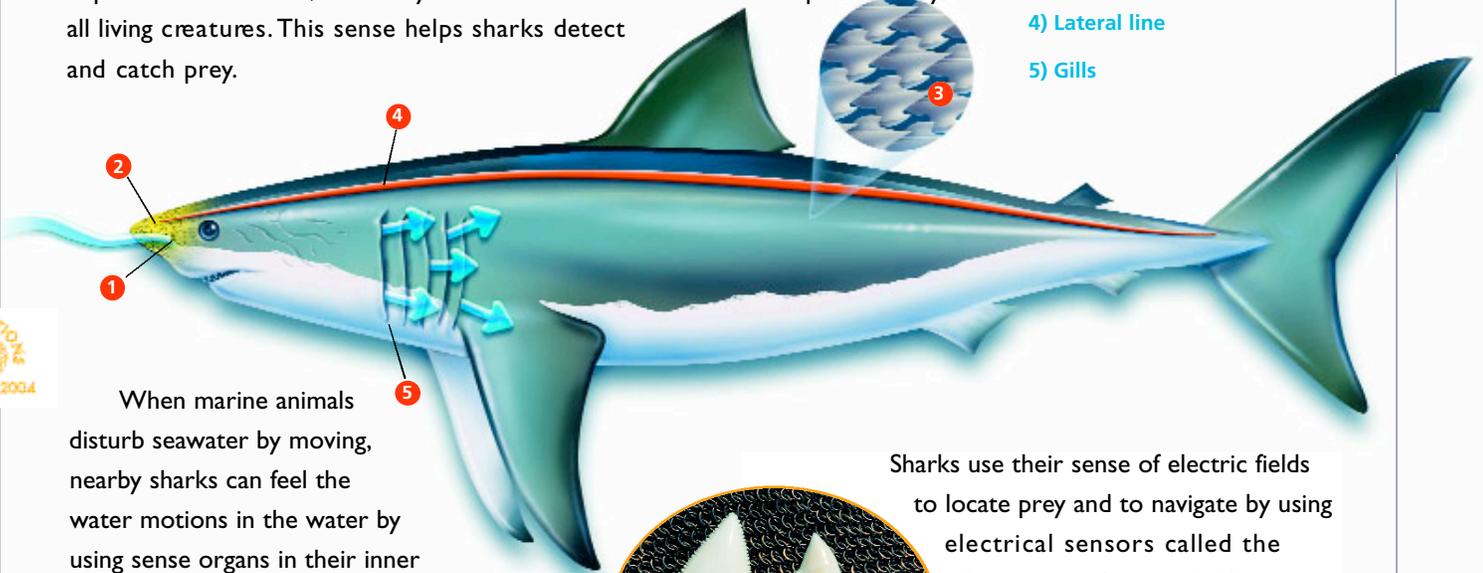


A diver wears a shark suit to protect herself.

SHARK SENSES

Sharks have the same senses that we do. They taste, see, smell, touch, and hear. But how they sense things is very different from people. Also, they have an important extra sense, the ability to detect the weak electric fields produced by all living creatures. This sense helps sharks detect and catch prey.

- 1) Nostrils
- 2) Ampullae of Lorenzini
- 3) Dermal Denticles
- 4) Lateral line
- 5) Gills



When marine animals disturb seawater by moving, nearby sharks can feel the water motions in the water by using sense organs in their inner ears and their lateral line sense organs just under the skin. The lateral line consists of an elaborate canal system in the head region, plus one long tube that runs all the way from the head to the tail on both sides of a shark's body.

Sharks use their nostrils to smell things rather than to breathe. They have an excellent sense of smell and can detect blood from long distances away if the water carrying the odor is flowing in the right direction.



Sharks use their sense of electric fields to locate prey and to navigate by using electrical sensors called the "ampullae of Lorenzini." These sensors are located in the head and are connected to pores distributed over the skin of the head, including the snout. They take advantage

of the fact that all living creatures produce a small electric field. Even if a shark can't see or smell you, it might be close enough to detect your bioelectric field, which all animals produce in seawater.

In 1971, Scripps scientist Adrianus Kalmijn showed that dogfish sharks use this electrosense to find food. He let a flatfish bury itself underneath some sand in a tank and then let the dogfish out. The shark went to the flatfish's hiding place and ate the fish. Could the dogfish shark have smelled the fish without seeing it?

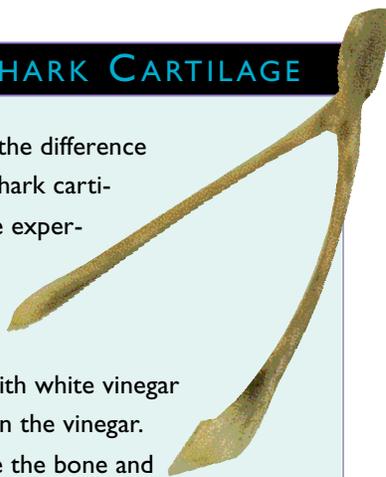
Dr. Kalmijn performed other experiments that proved that the shark still detected living prey even when the smell and water motions were excluded. The shark found the electrical gadget simulating the bioelectric fields of prey, but it couldn't find the smelly piece of nonliving fish. A shark uses its electric sense not only for detection of prey but also for navigation by electrically orienting to ocean currents and to the earth's magnetic field.

Without proper understanding of the sharks' sensory world, nobody will ever understand these magnificent animals, Kalmijn says.

FISH BONE VERSUS SHARK CARTILAGE

If you want to compare the difference between fish bone and shark cartilage, you can do a simple experiment at home.

Take a clean chicken bone and place it in a tall, thin jar. Fill the jar with white vinegar until half of the bone is in the vinegar. After a few days, remove the bone and try to bend each half. The side that was in the vinegar should be more flexible, like cartilage. It's more flexible because the acid in the vinegar dissolved the calcium, which made the bone strong. What you now have is flexible cartilage without the calcium.



CAN SHARKS BE SAVED?

New species of sharks are still being discovered, but at the same time fishermen are finding fewer sharks to fish.

It's estimated that people kill 30 million–100 million sharks each year. For the past 20 years, many shark populations have been rapidly declining because there is an increasing demand for shark meat, cartilage, and fins.

Since ancient times, shark fins have been considered a prized delicacy. Today, shark fin soup is so popular that a pound of dried shark fins can be sold for more than \$700. Shark finning

involves catching a shark, cutting off its fins, and tossing the doomed shark back into the water. The United States banned this practice in 2000.

Millions of sharks are accidentally killed each year when they are caught on hooks and in nets set for other fish like tuna and swordfish. This unwanted catch is called

“bycatch.” To help reduce bycatch, different fishing methods can be used. But it's up to us to support those fishermen who use these intelligent practices.

It is difficult for shark populations to recover from over-fishing

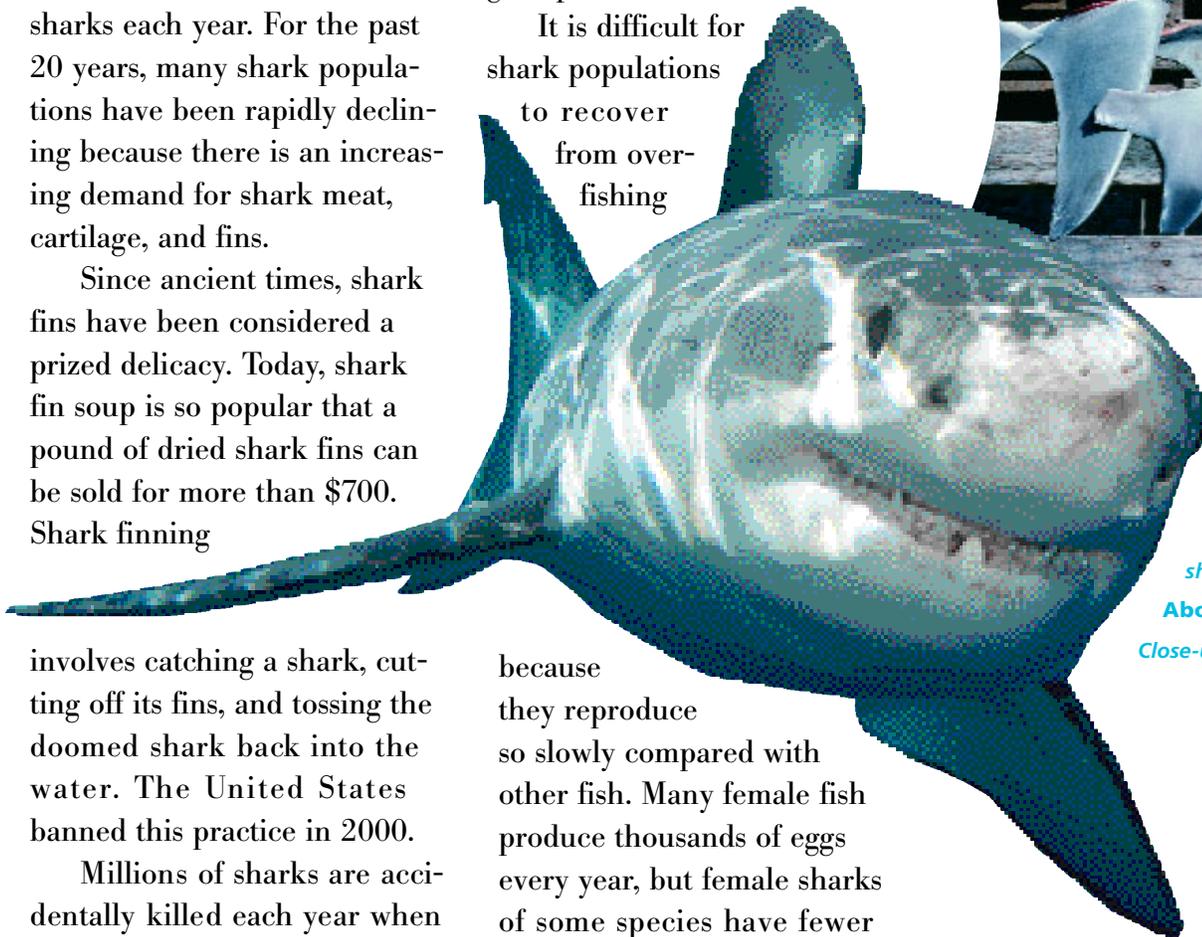
because they reproduce so slowly compared with other fish. Many female fish produce thousands of eggs every year, but female sharks of some species have fewer than a dozen pups in their lifetime. It takes some shark species more than 10 years to double their populations.

To help sharks, you can choose to stop eating those whose populations are dwindling and you can support fishermen who use safe and smart fishing practices. This will help shark populations recover so that they will be around for millions of years to come. 🌍



Above top,
Sharks whose fins have been removed for shark fin soup.

Above bottom,
Close-up of shark fins.



SEE SHARKS CLOSE-UP at the Birch Aquarium at Scripps

To find out more about sharks and see them up close, you can visit the 13,000-gallon shark tank at the Birch Aquarium at Scripps. There you will find whitetip and blacktip reef sharks as well as wobbegongs.