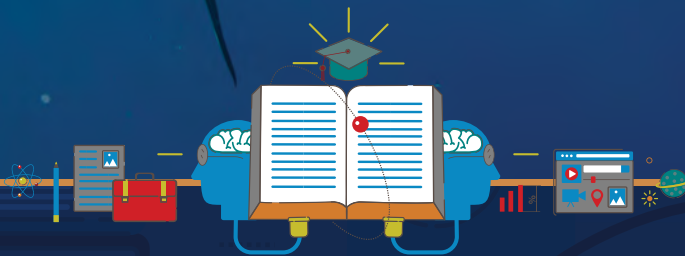


CALIFORNIA WHITE SHARK

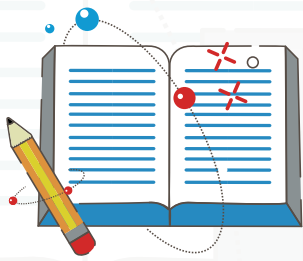
A SCIENCE 3D ADVENTURE

GRADE 3



By MIKE HEITHAUS Ph.D

symbioeducationSM



KEY WORDS

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

BIODIVERSITY

COLD-BLOODED

CONDUCTOR

EXTINCT

FOSSIL

HABITAT

HERBIVORE

NON-RENEWABLE RESOURCE

PALEONTOLOGIST

PREY

PREDATOR

RENEWABLE RESOURCE

SPECIES

WARM-BLOODED

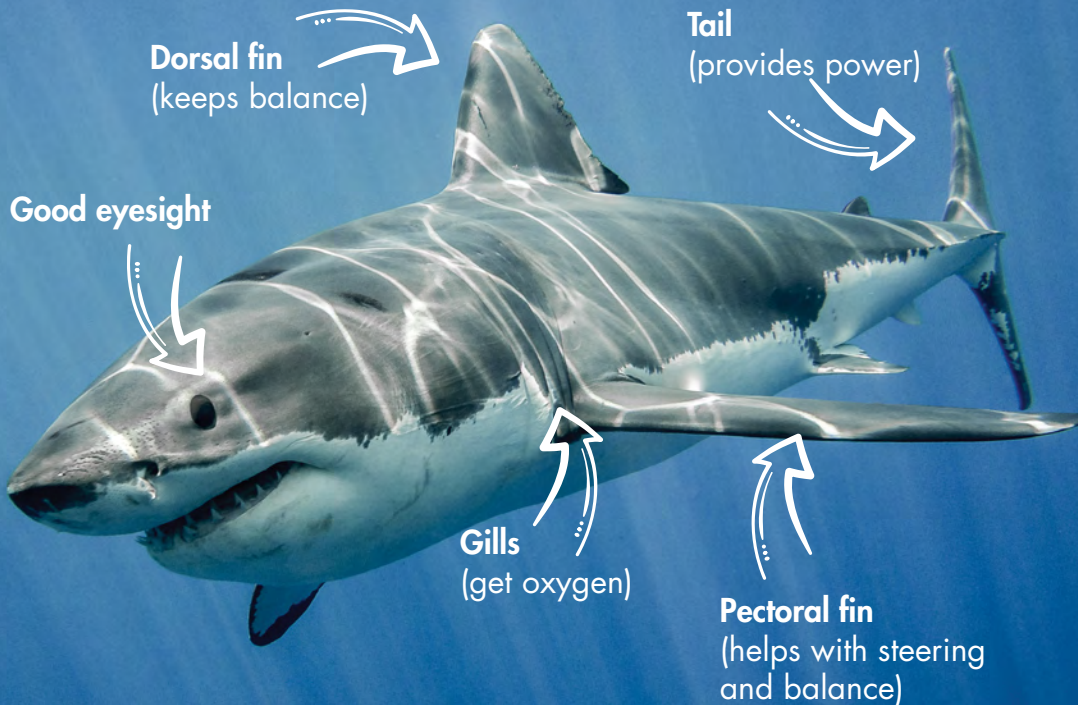


TABLE OF CONTENTS

White Shark!	2
Sharks of the Past	4
Staying Warm	8
White Shark Life Cycle	10
Life on the West Coast	12
Seal or Sea Lion?	14
California Habitats	18
Important Otters	26
Troubled Waters?	28
Bouncing Back	30
White Sharks and People	32
Studying White Sharks	23
Glossary	35

WHITE SHARK!

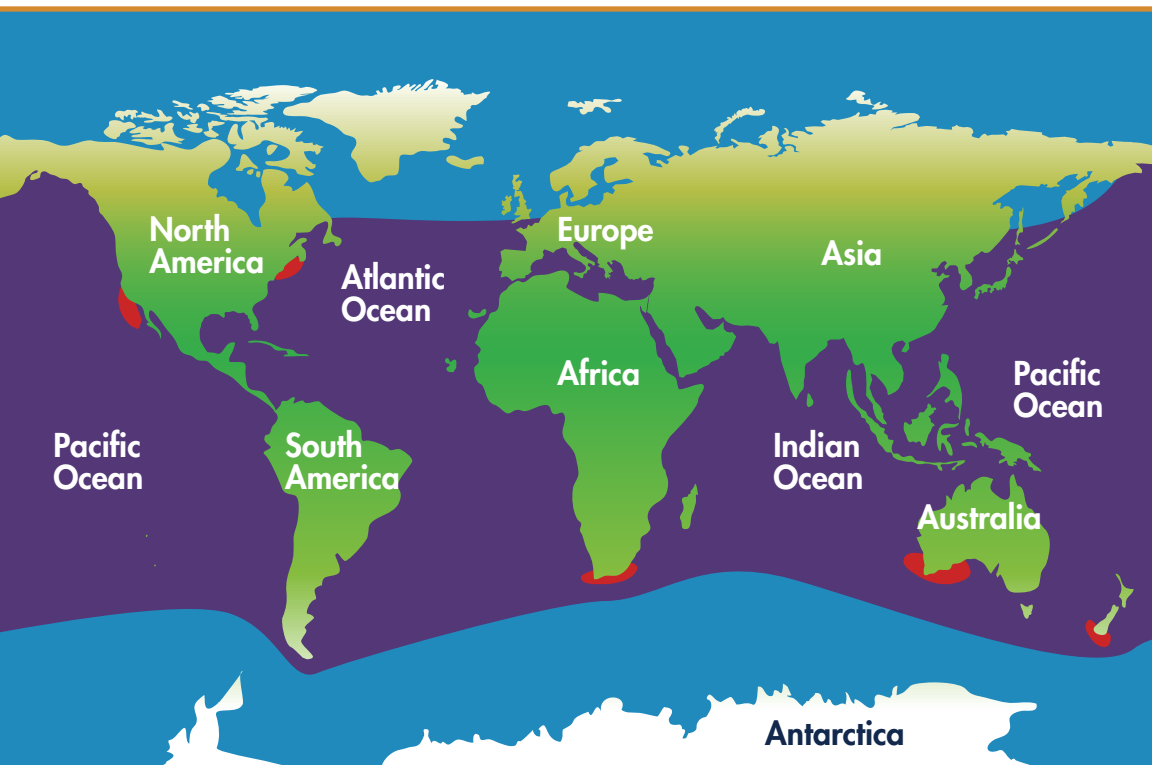
When you hear the word *shark* you might imagine one of the most famous sharks of all – the white shark! There are more than 500 kinds of sharks, but white sharks are very well known. They can grow to be 6 meters (20 feet) long. They can weigh almost 2,000 kilograms (over 4,000 pounds). That is as heavy as a large car!



White sharks are one of the ocean's top **predators**. They eat other animals.

White sharks live in oceans all over the world! But, there are places where many white sharks are found. These are called white shark hotspots! For many years the number of white sharks was very low. Now, their numbers are increasing again.

WHITE SHARK RANGE & HOTSPOTS



White shark range



White shark hotspots

White sharks can be found in almost every ocean on Earth! White shark hotspots are places where they are found in greater numbers.

SHARKS OF THE PAST

Paleontologists are scientists that study ancient life. They study **fossils**, or remains of organisms that are preserved in rocks. Looking at a fossil's features helps paleontologists learn how that plant or animal lived. The rocks that fossils are found in give clues about the ancient environment.

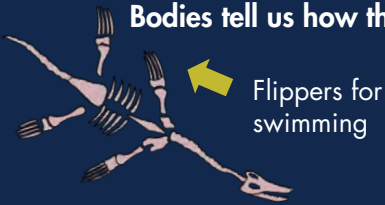
Teeth give clues about what animals ate.



Predators have sharp teeth

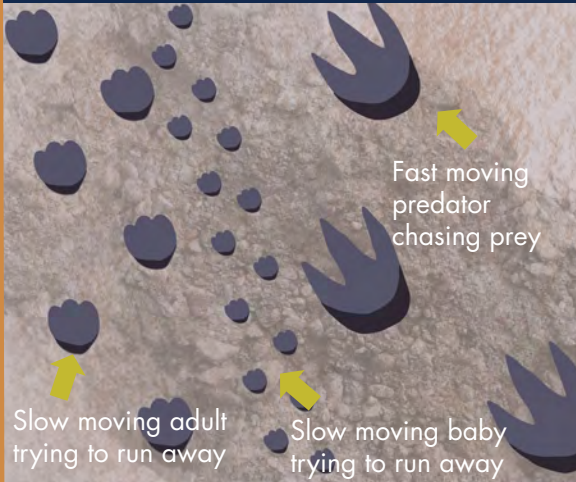
Herbivores have flat teeth

Bodies tell us how they moved.



Flippers for swimming

Fossilized tracks can tell us the size and speed of animals. They can also tell us about behaviors.

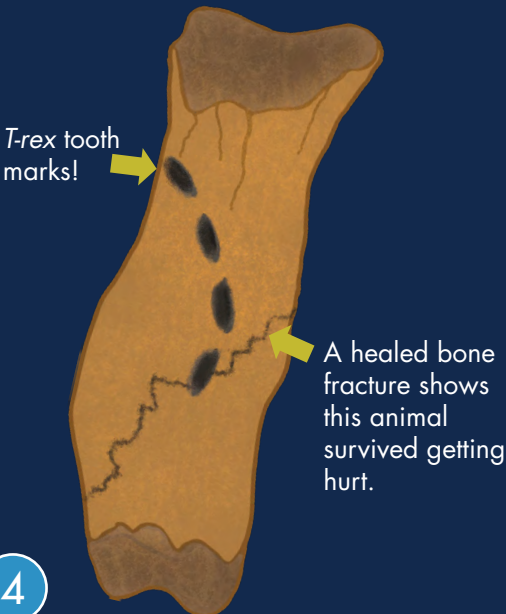


Fast moving predator chasing prey

Slow moving adult trying to run away

Slow moving baby trying to run away

Marks on fossil bones can tell us about predators and lifestyle.



T-rex tooth marks!

A healed bone fracture shows this animal survived getting hurt.

Types of rock and fossil can tell about ancient environments.



Leaf fossils means this was a swamp.

Fish fossils means this was an ocean habitat.

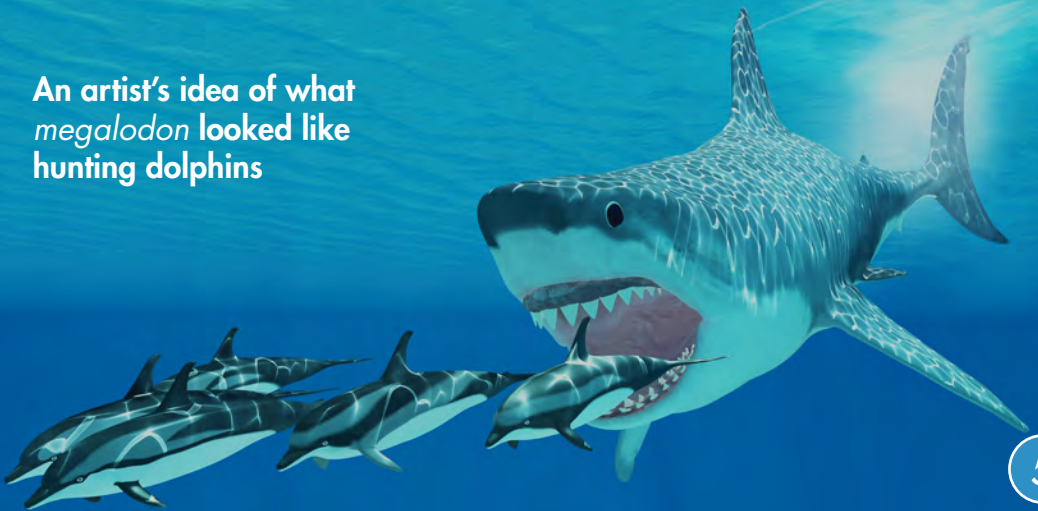
Older fossils buried deeper

Adult white shark tooth
compared to a fossil
megalodon tooth



White sharks are not the biggest predatory sharks to ever live. *Megalodon* is an **extinct** shark that was much bigger! It grew to over 15 meters (50 feet) long. That is as long as a school bus! A *megalodon* would make a full-grown white shark look small! How do we know? Paleontologists found the fossil teeth of *megalodon*. Using these fossils, they can tell how big *megalodon* was and what it ate. The shape of the tooth shows it could eat big prey. Cuts from a megalodon's teeth are found on fossil dolphins, fish, manatees, sea turtles and whales. That is quite a menu!

An artist's idea of what
megalodon looked like
hunting dolphins





Pterosaur fossil



A shark tooth fossil stuck in a pterosaur's neck!

Sharks have been around since before dinosaurs. Paleontologists have even found evidence that ancient sharks ate extinct flying reptiles called pterosaurs!



Is this what happened?



Check out
those teeth!

STAYING WARM

White sharks are special! They are one of the biggest sharks that eats big prey. They are also able to live in cold water. Many other sharks need to stay in warm waters. Why is that?

Water is a good **conductor** of heat. Have you ever gone swimming and felt cold? This happens because the water is colder than your body. The heat moves out of your body and into the water. Eventually, you get cold and shiver to warm up.

But the bodies of most sharks can't make heat to get warm. They are **cold-blooded**. That means that their bodies are the same temperature as the water around them. Cold-blooded sharks have to find warm water to get warm. A cold-blooded shark would get too cold and die in cold water. That is the main reason many species of sharks, like tiger sharks, are found in warmer waters.

Lizards are also cold-blooded. When they get cold, they find a sunny spot to lie down to warm up!



Lizard warming up in the sun



Tiger shark in warm water

Lizards are cold-blooded. They use the sun to warm up their bodies. Most sharks are also cold-blooded. To stay warm, they need to live in warm water. But white sharks are different!

White sharks are **warm-blooded**. Their bodies can generate heat. Since they stay warmer than the water around them, they can live in cold water. Only a few sharks besides great white sharks are warm-blooded. Mako sharks, salmon sharks, and thresher sharks are also warm-blooded! To generate heat, white sharks need more energy than cold-blooded sharks. That means they need to eat a lot of **prey**. Mammals and birds are also warm-blooded.

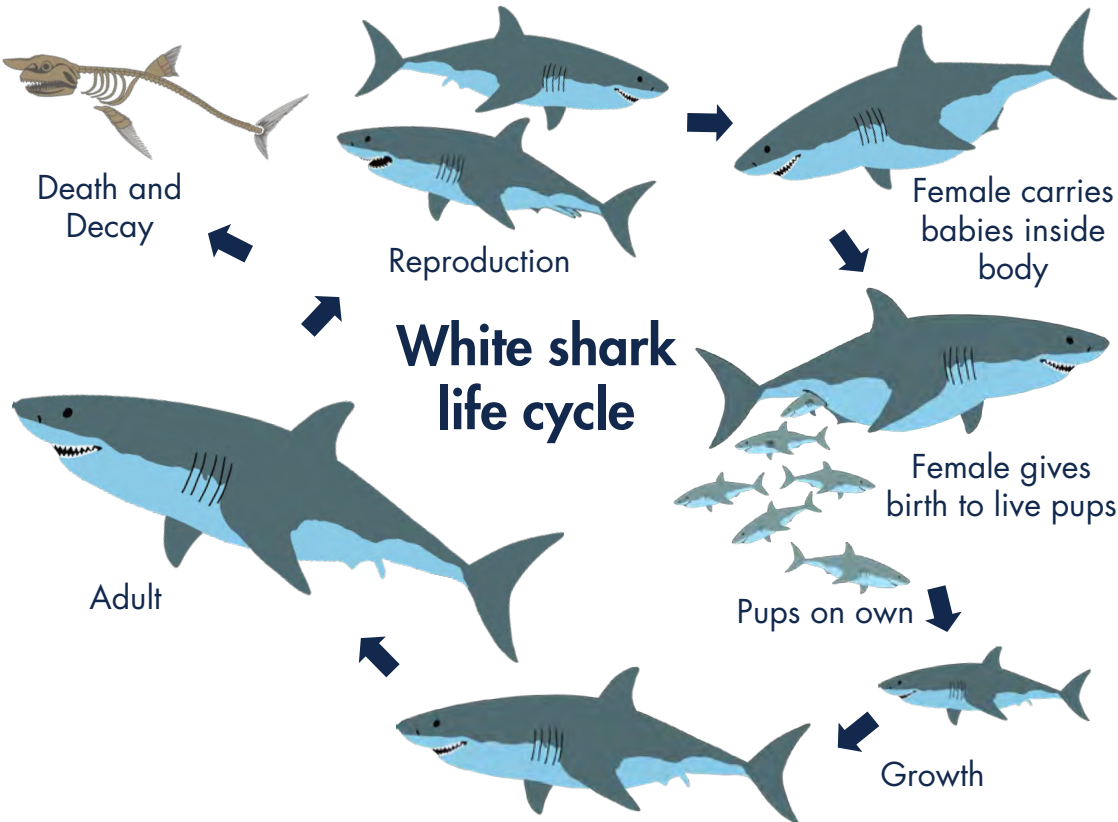


The dark back of a white shark blends into the dark ocean bottom. This helps them sneak up on prey swimming above. When they get close enough, they rocket up from below! But, white sharks don't always catch their prey.

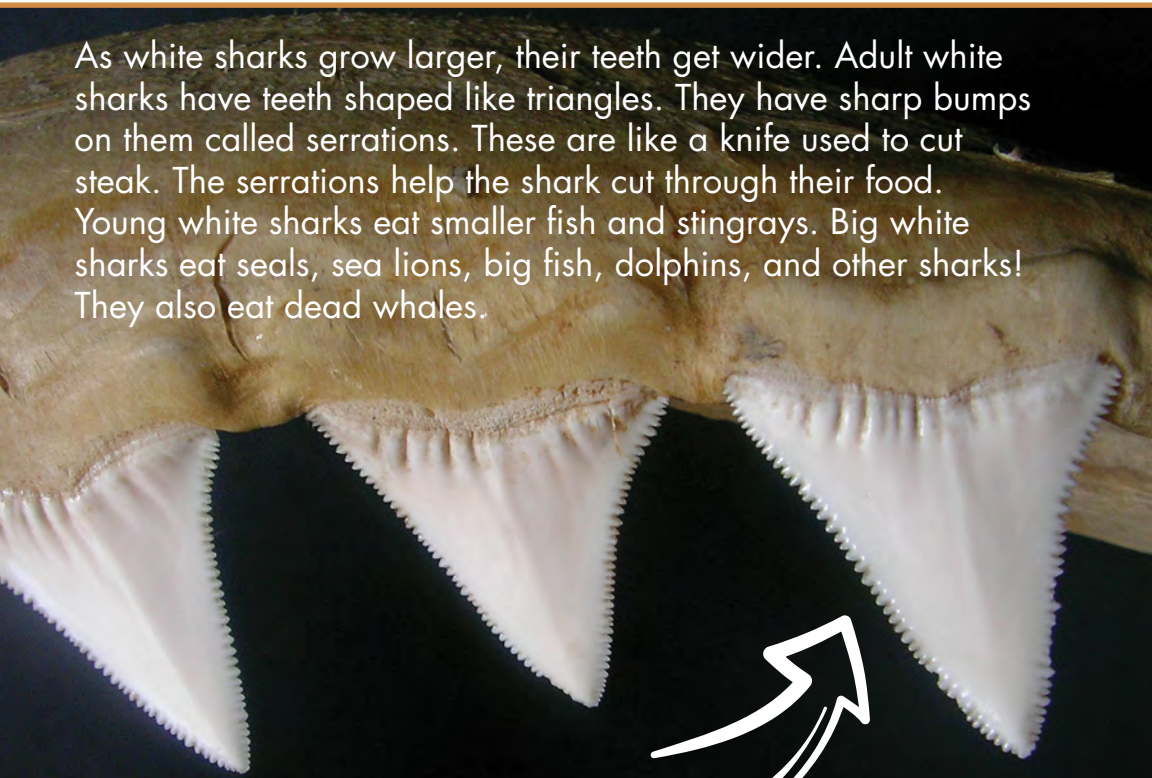
WHITE SHARK LIFE CYCLE

They may be big when they are fully grown, but white sharks don't start out that way. Female white sharks carry their babies, called pups, inside them while they grow. After about 12 months of being pregnant, the pups are born. They are usually about 1.5 meters (4.5 feet) long. The mother shark doesn't care for her young. The pups are ready to swim and eat as soon as they are born. Females usually give birth to around ten pups at a time. White sharks may be 20 years old before they reproduce. It is difficult for scientists to measure how old white sharks can get. They may live to be 70 years old!





As white sharks grow larger, their teeth get wider. Adult white sharks have teeth shaped like triangles. They have sharp bumps on them called serrations. These are like a knife used to cut steak. The serrations help the shark cut through their food. Young white sharks eat smaller fish and stingrays. Big white sharks eat seals, sea lions, big fish, dolphins, and other sharks! They also eat dead whales.



These teeth are made for cutting!



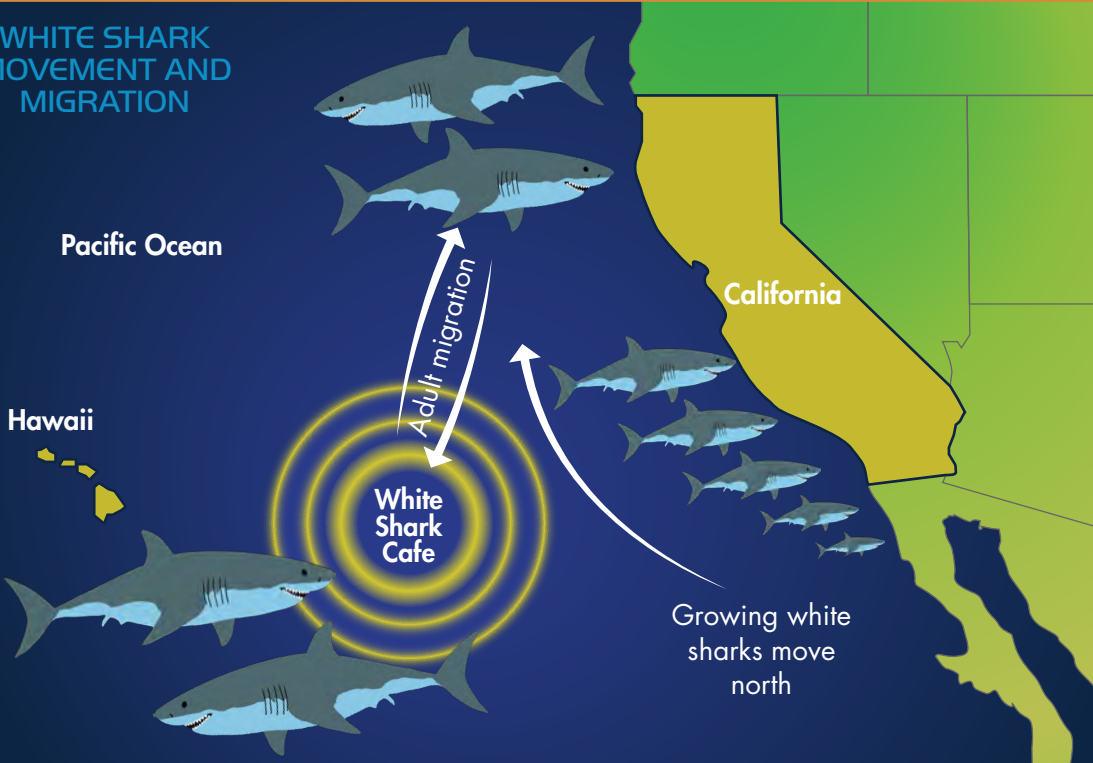
LIFE ON THE WEST COAST

One of the best places to find white sharks of all sizes is California! But sharks of different sizes are not usually found in the same place. Babies are found in southern California. As the sharks get older, they start moving further along the coast. Larger adults are usually found in northern California. Large white sharks like to spend time near places with a lot of seals and sea lions.



White sharks don't spend all of their time along the coast. Adults swim far offshore for parts of the year. They go to a place in the middle of the ocean that scientists call the "White Shark Cafe." After a few months, they come back to the coast. Scientists are trying to learn why sharks make these long-distance swims.

WHITE SHARK MOVEMENT AND MIGRATION



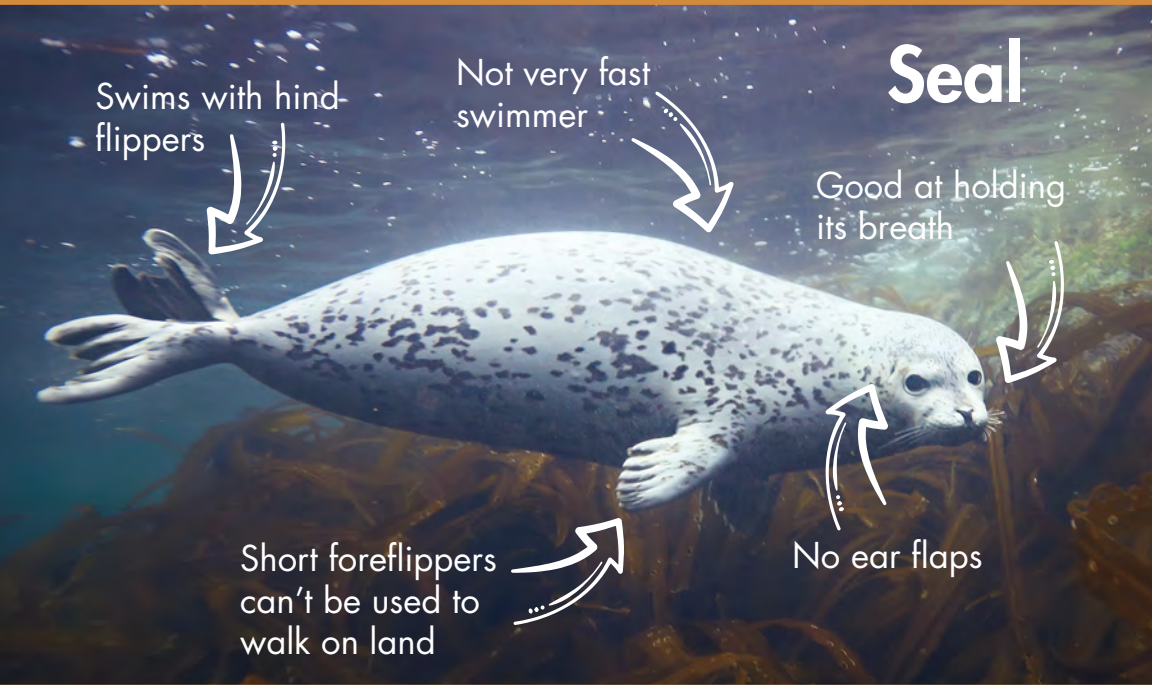
(Above) Adult white sharks migrate to and from an area in the Pacific Ocean known as the "White Shark Cafe." Young white sharks move up the California coast as they grow. (Below) Scientists use technology to learn more about sharks.

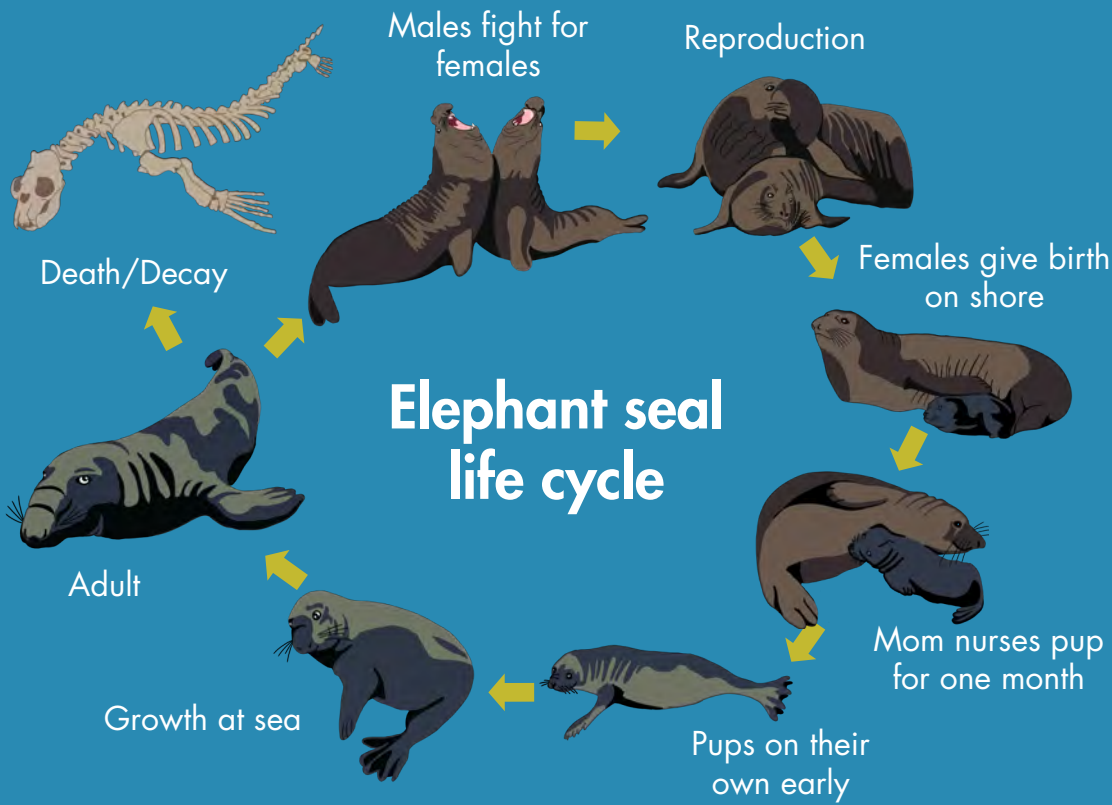
Satellite tag on a white shark



SEAL OR SEA LION?

Seals and sea lions can be found swimming, lying on beaches, or hanging out on rocks along the coast. Seals and sea lions look similar, but they are different kinds of animals.





Big white sharks spend time close to where seals and sea lions rest. There are two dangerous times for seals and sea lions. Once, when they are leaving the beach to find food. And again, when they are almost back to shore.

Sea lions have to leave and come back almost every day! They have to swim through the danger zone a lot. Luckily, they are fast and can make quick turns! They can escape attacks! Sometimes they will leave and return to shore in groups. Swimming together keeps them safer!

Elephant seals have a lot of fat! Their fat keeps them warm in cold water. Their bodies can use the fat as energy. This allows them to stay on shore for months without eating. Elephant seals aren't very fast swimmers. They can't turn very fast. It is a good thing they only travel to and from the beach a couple times a year. They make very few trips through the shark danger zone!





Elephant seals get their name from the long nose of the adult males. It looks like a small elephant trunk!

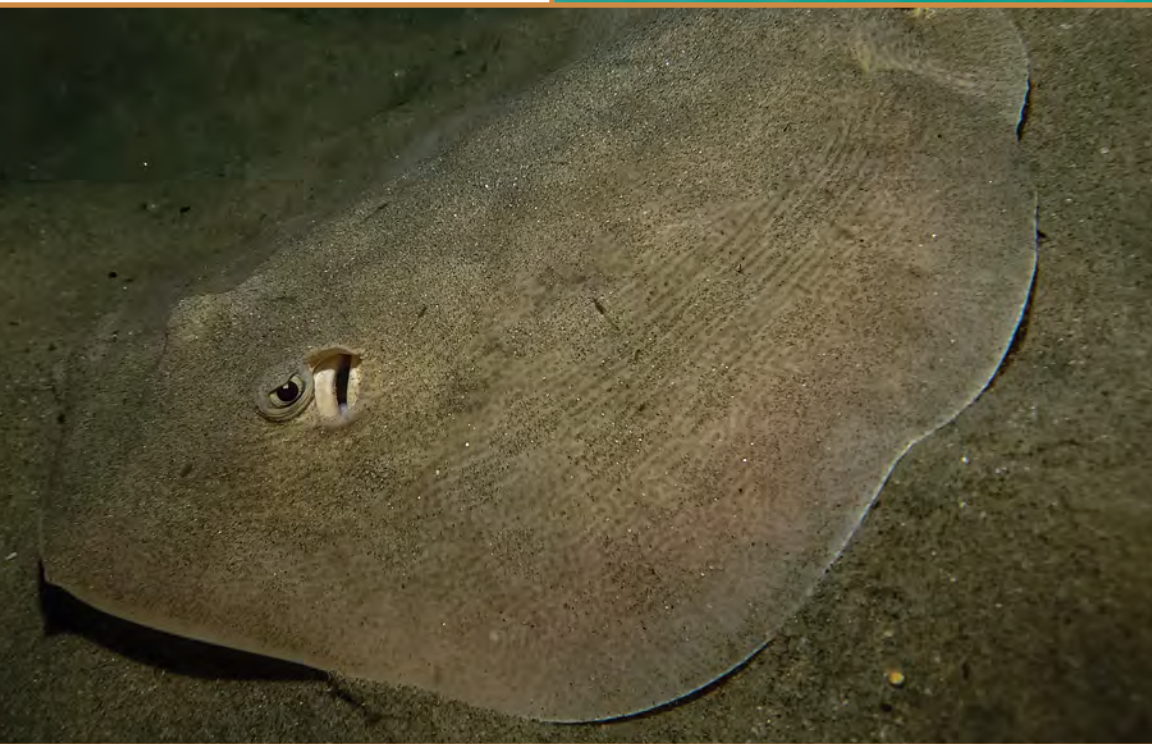
CALIFORNIA HABITATS

White sharks are found in all of California's ocean **habitats**.



JUST OFFSHORE

Many people like to go to the beach in California. They enjoy swimming, surfing, and paddling in the shallow waters. Baby white sharks like these shallow waters too! They can find food there. One of their favorite foods seems to be stingrays. There can be thousands of stingrays just off the beach! People need to listen to the lifeguards and read signs to make sure they do not step on a stingray!



Stingrays can give people a nasty sting! Do baby white sharks eat enough stingrays to keep their numbers small? Could baby white sharks help keep people safe from stingrays at the beach?

OPEN WATER

Baby white sharks usually stay close to shore. This could be to find food or stay safe from their predators. Big mako sharks and killer whales might eat a baby white shark if they move too far from shore. How do the species that venture into deeper waters stay safe?

Some species found in deep water grow to huge sizes. Not many predators can take on a blue whale. They grow to more than 30 meters long! That is 100 feet!





For other animals, living in a group is the key to survival. Small fish live in huge schools. By living together, they are less likely to become prey. Dolphins form large groups to stay safe from sharks and killer whales. Being in a group can also help them find and catch food!



A vibrant underwater scene showing a dense kelp forest. The water is a clear, deep blue, and the kelp stalks are a rich green-brown color. The leaves are long and narrow, with some showing small white spots. The overall atmosphere is serene and natural.

UNDERWATER FORESTS

One of the most famous underwater habitats of California is the kelp forest. Baby white sharks swim near kelp forests. Kelp is a huge alga, or underwater seaweed. Like plants, it can produce its own food from sunlight! Kelp can grow to be more than 45 meters (over 150 feet) tall! They grow really quickly. Some kelp can grow about a foot in a day!



Air filled balls on kelp help the top float at the surface.

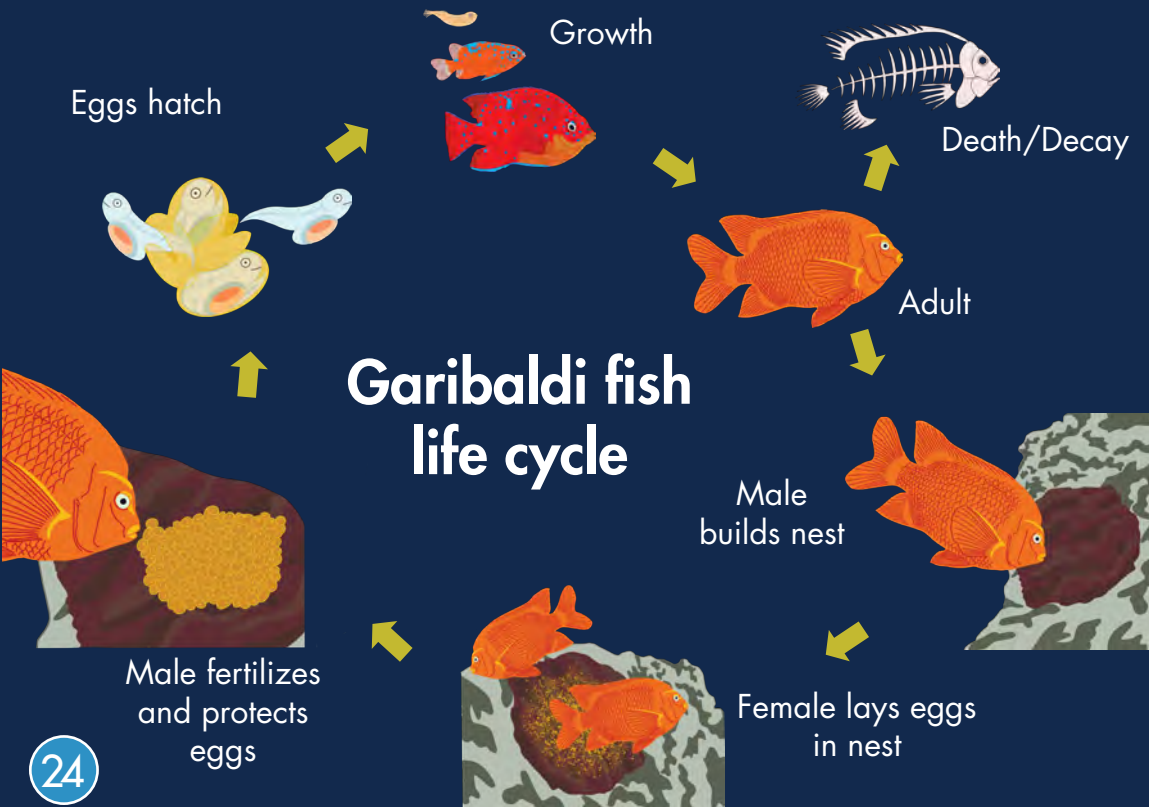
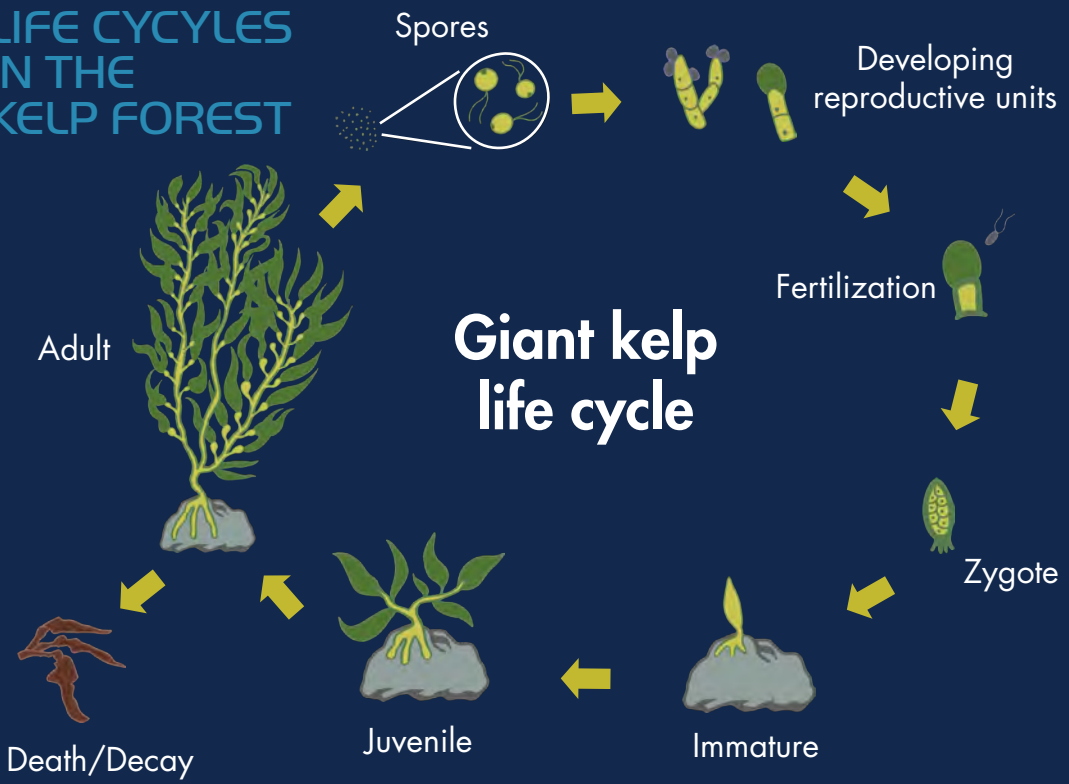
Kelp have structures that help them hold onto rocks at the bottom so they don't float away. They also have special air-filled sacs that keep the top of the kelp afloat at the surface.

Fish, crabs, seals, and many other species find shelter, or live in, the kelp forest. Many of these species are food for white sharks!



Kelp forests provide food and shelter for many species, like this harbor seal.

LIFE CYCLES IN THE KELP FOREST



An underwater photograph showing a vibrant kelp forest. The water is a clear, deep blue-green. Several bright orange Garibaldi fish are visible. One large Garibaldi is in the center-right, swimming towards the right. Another smaller one is to its left, and a third is partially visible in the upper right corner. The kelp stalks and leaves are dark green and create a dense, textured background.

Garibaldi are bright orange fish.
They are common in kelp forests.

IMPORTANT OTTERS



Sea otters are the most famous animal in the kelp forest. They live most of their lives in the water. Their dense fur keeps them warm. Sea otters eat animals with hard shells, like crabs and sea urchins.

Sea otters are smart! They even use tools, like rocks, to smash open shells. Sea otters are important for the kelp! How do we know?



Young sea otter pups ride on the bellies of their mothers!

Many years ago, sea otters were hunted for their fur. They almost went **extinct**. There were no otters left to eat sea urchins, so sea urchins reproduced a lot. Soon, there were too many sea urchins. They ate almost all of the kelp. With no kelp, the fish and seals disappeared. Even animals above water, like eagles, left the area because there wasn't enough food for them.

Eventually, people protected sea otters. The number of sea otters increased. The sea otters ate a lot of sea urchins. Sea urchin numbers went down. The kelp forests grew back. Then, the animals that live in the kelp forests came back too!



TROUBLED WATERS

The waters of California are now home to amazing species. But they haven't always been so healthy. The decrease in sea otters was one of many problems. What happened?

People need energy for their bodies. Like white sharks, we get it from our food. We also need energy to power cars, electronic devices, and homes. The energy comes from resources in the natural environment. These resources can be **renewable** or **non-renewable**. Non-renewable resources can only be used once. Fossil fuels are one example of non-renewable resources. Oil, coal, and natural gas are fossil fuels. To get them, people have to dig them up or pump them out of the ground. Once they are all used, they are gone forever.

Renewable resources can be replaced naturally. They do not run out. Energy from the sun and power from wind are kinds of renewable energy. Even when they are used, more energy is produced. Plants can be used to make renewable fuel. But people need to make sure they don't use the fuel quicker than plants grow!



Sun and wind provide
renewable energy

What do resources have to do with white sharks? Many years ago, people pumped a lot of oil out of the ground in California. They were not careful about what was being put in the water and air. Oceans became very polluted. Populations of many species, including white sharks, decreased.

The **biodiversity**—or number of **species**—in polluted areas went down. Some species disappeared from polluted areas. Also, people used to hunt seals and sea lions. They caught too many white sharks. Populations of seals, sea lions, and white sharks all went down. Elephant seals almost went extinct!

Gray whale



Elephant seal



White shark



Blue whale



Sea lion



Rockfish

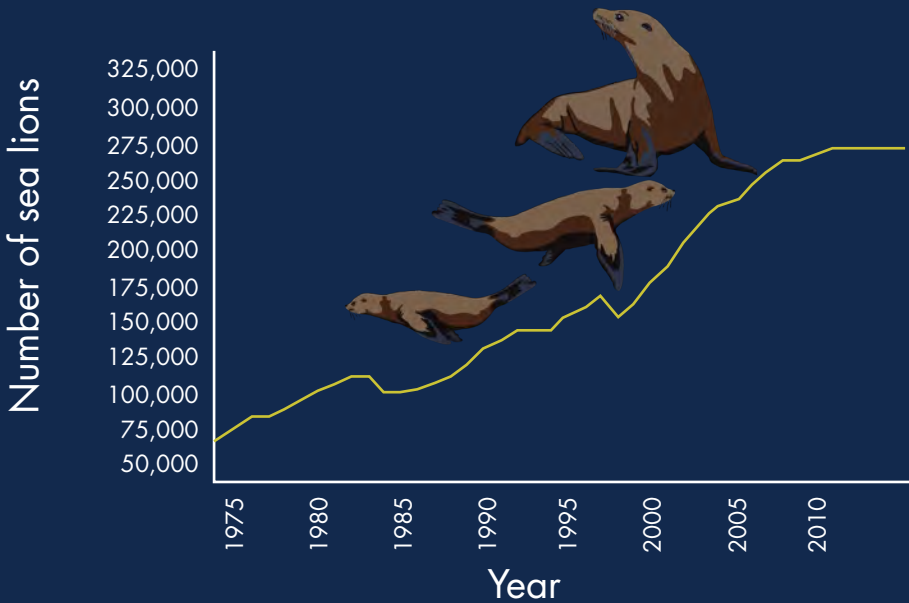


Reducing hunting, fishing, and water pollution helped increase the biodiversity of California!

BOUNCING BACK

People decided to do something about all of the problems. They started to protect seals, sea lions, and sharks. They made sure that the government passed laws to keep the air and water clean. Engineers developed solutions to reduce pollution. They developed ways to clean up dangerous chemicals from the water. People also started to recycle materials, like cans, they used to throw away. They found ways to make less trash and less pollution!

California's oceans used to be some of the most polluted in the United States. Now they are clean! Many species have returned. Populations of seals and sea lions are growing. That means there is a lot of food for white sharks. Are the white shark populations growing too?



Number of sea lions in California from 1974–2014. Do you think that the solutions people used to protect them worked? What evidence supports your claim?

California sea lion



SHARKS AND PEOPLE

White sharks are big, and they eat big prey. Very large white sharks can be dangerous to people. Sometimes they do bite people, but it doesn't happen very often. When they do bite people, they most likely think they are prey. It is a mistake.

People are learning to live with white sharks. They avoid places where big sharks might be found. Lifeguards keep an eye out for big sharks. They tell people when to get out of the water.

People see baby white sharks near beaches in Southern California. Dr. Chris Lowe and his team at the Shark Lab at California State University, Long Beach study these sharks. How long do the baby sharks stay in one place? Why do they like certain areas? How do they behave near surfers? Will baby white sharks reduce stingray populations? Are white shark populations growing? The Shark Lab is trying to answer all of these questions. You will join the team to help. But first, let's explore how they study sharks!

White shark



STUDYING WHITE SHARKS

Baby white sharks live very close to the shore where the waves are big and water is murky. That makes it very hard to study them. But biologist Dr. Chris, software engineer Darnell Gadberry, and the rest of the Shark Lab team solved these problems! The team uses a lot of technology. Submarines can map the bottom of the ocean. Tags on sharks can show where they travel. Drones can help count sharks from the air. Now, let's join the team to study California's baby white sharks!



Engineer
Darnell Gadberry



Marine Biologist
Emily Spurgeon



Marine Biologist
Dr. Chris Lowe



Shark Lab team
at work!





GLOSSARY

BIODIVERSITY

the number of species in an area

COLD-BLOODED

having a body temperature that is the same as the environment

CONDUCTOR

a substance that transmits heat, electricity, or sound

EXTINCT

a species or group of organisms no longer in existence

FOSSIL

the remains of an ancient organism preserved in a rock

HABITAT

the place an animal or plant lives

HERBIVORE

an animal that eats plants

NON-RENEWABLE RESOURCE

a natural substance or material that cannot be quickly replaced by nature

PALEONTOLOGIST

a scientist that studies the fossils of animals and plants

PREY

an animal that is eaten by other organisms

PREDATOR

an animal that catches and eats other animals

RENEWABLE RESOURCE

a natural substance or material that can be quickly replaced by nature

SPECIES

a particular type or group of organisms

WARM-BLOODED

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

PHOTO CREDITS

Abbreviation Key: SS = Shutterstock.com

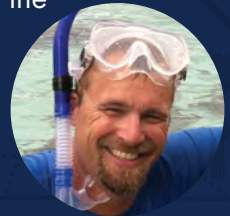
Front cover, William Bradberry/SS; 2, Ramon Carretero/SS; 5 (top), Mark Kostich/SS; 5 (bottom), Catmando/SS; 6 (top), Dinosaur Institute - Natural History Museum Los Angeles County; 6 (middle), David Hone; 6 (bottom), Mark Witton; 7, Vincent Legrand/SS; 8 (left), jempeng/SS; 8 (right), Marion Kraschl/SS; 9 (middle), Alessandro de Maddalena/SS; 9 (bottom), Sergey Uryadnikov/SS; 10, Ramon Carretero/SS; 11, Alessandro de Maddalena/SS; 12, Sebastien Burel/SS; 13 (bottom left), CSULB Shark Lab; 13 (bottom right), CSULB Shark Lab; 14 (top), Kichigin/SS; 14 (bottom), Daniel Avram/SS; 16, worldswildlifewonders/SS; 17, SS; 18, Asif Islam/SS; 19 (top) Petra Christen/SS; 19 (bottom), Timothy Mcdade/SS; 20, SS; 21 (top), David A. Litman/SS; 21 (bottom), Chase Dekker/SS; 22, Ethan Daniels/SS; 23 (top), NatalieJean/SS; 23 (bottom), Brandon B./SS; 25, VisionDive/SS; 26 (top), Chase Dekker/SS; 26 (bottom), worldswildlifewonders/SS; 27 (middle), Ethan Daniels/SS; 27 (bottom), SS; 28, Blue Planet Studio/SS; 29 (top left), Tomas Kotouc/SS; 29 (middle left), Palomba/SS; 29 (bottom left), EB Adventure Photography/SS; 29 (top right), creative/SS; 29 (middle right), Andrew Sutton/SS; 29 (bottom right), Reimar/SS; 31, gdvcom/SS; 32, Alessandro de Maddalena/SS; 33 (middle left), Symbio Studios; 33 (bottom left), CSULB Shark Lab; 33 (middle right), Symbio Studios; 33 (bottom right), CSULB Shark Lab; 34, Martin Prochazkacz/SS; Photo credits, Sergey Uryadnikov/SS; Back cover, Palomba/SS

SCIENCE 3D

Thanks for exploring with us! Our science adventures take us around the world to uncover secrets of the most amazing animals and places. Our mission and passion is 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 a scientist, 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 with people to help protect these species. Mike loves sharing his work with others. He has written text books and helped create programs for students in elementary, middle, and high school. He has been on television programs including 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's 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.





CALIFORNIA WHITE SHARK

A SCIENCE 3D ADVENTURE

symbioeducation™



LEXILE® LEVEL

690L

SCIENCE 3D®. ALL RIGHTS RESERVED



ISBN: 978-1-954681-10-1
WWW.SCIENCE3D.EDUCATION