SHARKS

EDUCATOR'S GUIDE

Jean-Michel Cousteau's Ocean Futures Society

www.sharks3D.com

UNEP

Reef Check

PADI Project AWARE

Tom Ordway, Ocean Futures Society

"To inspire and educate people to act responsibly in order to ensure the preservation of the world's oceans is a mission the film and I have long shared."

Jean-Michel Cousteau, Ocean Explorer

3D Entertainment

"As many fellow conservationists have stated before, we protect only what we love. Therefore, we first need to understand what sharks are really like before there can be a change in public perception. Then perhaps we will begin to protect them."

Jean-Jacques Mantello, Director

Text and Illustrations by Lauren Ayotte.
Edited by Dr. Elisabeth Mantello and Alexandra Body.

SHARKS is produced by *3D Entertainment*, a company that specializes in the production and distribution of marine conservation and environmental-themed films for the worldwide network of IMAX theatres, and *McKinney Underwater Productions Inc.* Our mission is to immerse audiences in films that inspire and educate.

Directed by Jean-Jacques Mantello, filmed by Gavin McKinney and executive produced by François Mantello. **SHARKS** features an original score composed by Christophe Jacquelin and performed by the Bulgarian Symphony Orchestra.

SHARKS is distributed worldwide by *3D Entertainment* in collaboration with the *United Nations Environment Programme* and is endorsed and supported by Jean-Michel Cousteau's *Ocean Futures Society*, *Reef Check* and *PADI's Project Aware*.

Websites:
http://www.sharks3D.com
http://www.unep.org
http://www.oceanfutures.org
http://www.reefcheck.org
http://www.projectaware.org

Introduction

3D Entertainment is pleased to bring you and your students **SHARKS**, a new and exciting IMAX theatre documentary that takes audiences on an unforgettable journey into the fascinating underwater world of the most advanced predators on earth.

This 42-minute IMAX theatre documentary aims to rehabilitate the perception of sharks among the general population by showing them as they truly are in their natural habitat: not wicked man-eating creatures, as they are far too frequently depicted in modern feature films, but wild, fascinating and highly endangered animals.

SHARKS not only offers a unique and memorable educational presentation by recreating the actual sensations divers experience when they come face-to-face with these animals; it delivers a compelling conservation message. As such, it is an invaluable means of communicating the importance of protecting our increasingly fragile marine ecosystem and preserving its biodiversity.

With the aid of Aris Turtle, your friendly guide throughout the film, your students will learn about the behavior of many shark species that have been in existence since a million years before the dinosaurs -- the sand tiger shark, great white shark, scalloped hammerhead shark, gray reef shark and whale shark. Our goal is to increase their environmental awareness and change their perception of these endangered animals.

3D Entertainment, the production company behind this IMAX theatre film presentation, has teamed up with renowned ocean explorer Jean-Michel Cousteau and the United Nations Environment Programme, Reef Check and PADI's Project Aware to produce this Educator's Resource Guide. It was created to serve as a coherent source of information on sharks, and is meant to provide you with engaging activities for your students to do before and after viewing the film.

The material contained in this document was designed for use with students of elementary age through high school. You are encouraged to adapt any of the activities included to meet the specific needs of the grades you teach.

Further information such as the most important characteristics pertaining to each of the species featured in **SHARKS** and a list of external shark-related Internet links can be found in the "For Educators Only" section of our website at **http://www.sharks3D.com**

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UNIT I - What is a shark?

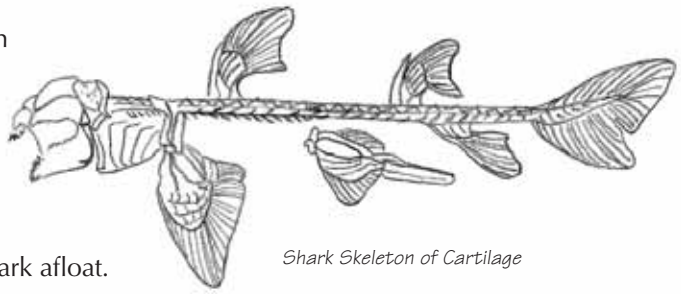
Sharks are amongst the ocean's most ancient animals and have evolved to become the ultimate predators. They were here 100 million years BEFORE the dinosaurs! And if you do the math, that means they've been around for about 400 million years! Man first appeared 3.5 million years ago…

Sharks can be found in all the oceans of the world. Some live in the cold polar waters and others prefer the warm tropical seas. Just as some sharks live in the depths of the ocean near the sandy bottom, others prefer to swim near the surface. Many live near a coral reef or are restricted to certain coasts. There are even a large number that choose to swim in the open ocean waters. Strangely enough, a few sharks will even venture into lakes and rivers; however, they do not generally stay there for long.

Principal photography on **SHARKS** required an extensive nine-month shoot totaling 500 dive hours. The film, shot on location in Guadalupe Island, Socorro Island and the Sea of Cortez (Mexico), Malpelo Island (Colombia), the Red Sea (Egypt), Sodwana Bay (South Africa), Mozambique Channel and Rangiroa Atoll (French Polynesia), consists uniquely of underwater footage, with none of the usual "dive preparation" sequences.

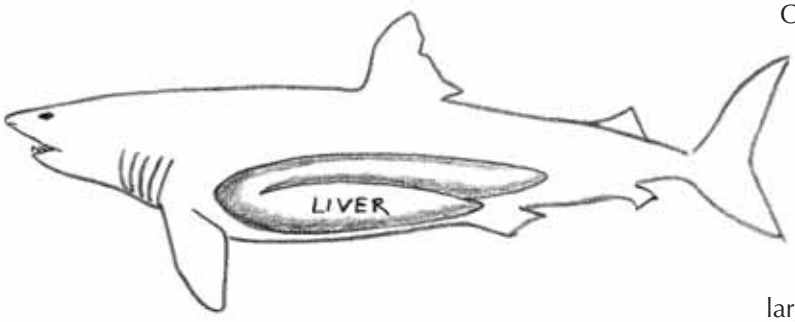
1. A Cartilaginous Fish

A shark is a fish. It is a fish because, like all fish, it swims with fins and breathes with gills. However, a shark is not just any fish. It is a cartilaginous fish as opposed to a bony one. A shark's skeleton is made of cartilage, a lightweight, rubbery material. We have cartilage in our ears and noses. Cartilaginous fish also differ from bony fish because they have five to seven gill slits (as opposed to one for bony fish). The lightweight aspect of cartilage actually helps keep the shark afloat.



Shark Skeleton of Cartilage

FUN FACT: Shark's cartilage continues to grow as long as they live.

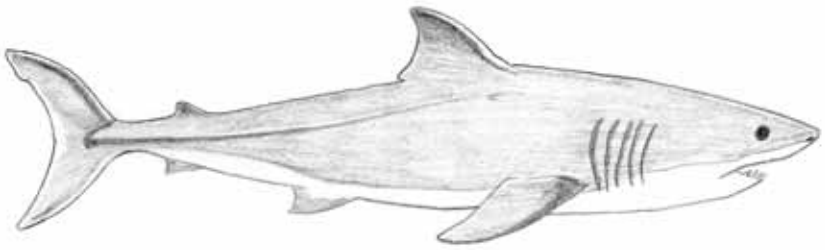


Cartilaginous fish are grouped together in a special class that includes rays and skates, and have one other trait in common: they have no swim bladder to help keep them afloat as bony fish do. Instead, they have a large oily liver.

An *oil rich liver* gives them buoyancy because oil is less dense, and thus lighter than water, but they still have to constantly swim to keep from sinking. Some of the larger sharks, like the whale shark, have enormous livers to keep them afloat as they mosey along in the water.

2. Shark Shape

Sharks have a streamlined shape like a torpedo. A typical shark has a oblong snout that is more pointed towards the end and a long tail fin. It is precisely this aerodynamic, or water-dynamic form that allows them to move their powerful body so easily and so quickly through water.



3. Shark Size

There are around 400 different species of sharks. Among these are the three largest fish in the sea - the whale shark, the basking shark and the megamouth - who are all harmless to humans. But sharks come in all different shapes and sizes. Fewer than 20% of all sharks are larger than humans. 50% of shark species never get larger than 1.80 m/6 feet, about the size of an adult man. Only 10 of all known shark species regularly reach a length of over 4 m/13 feet.

The average shark is only 60 to 90 cm (2 to 3 ft) long. The largest shark is the whale shark, which is larger than a bus or two elephants placed end to end. An adult male African elephant can be up to 4 m tall and 6 m long.
The world's smallest known shark is the dwarf lantern shark, which can fit in the palm of a person's hand.
The maximum length of a great white is 6.8 m/22.3 ft with a mass of more than 2 tons. An adult African elephant weighs between 4 to 7 tons: that is the equivalent to 3 to 6 cars! In **SHARKS** you will discover many sharks that are larger than humans.

4. Shark Fins

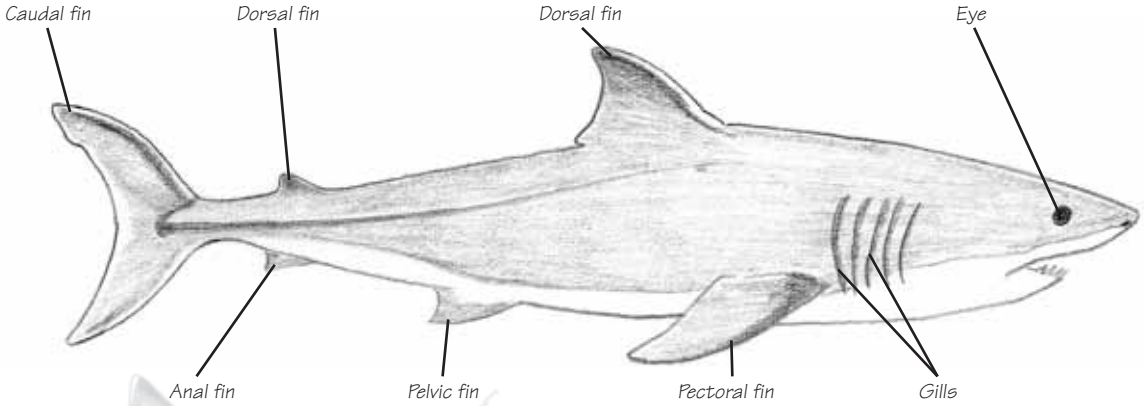
Fins play a crucial role for sharks. They are rigid, not flexible, and supported by rods made of hard cartilage.
Shark fins serve two major functions:

1. They stop the shark from rolling over and over.

A shark has one or two dorsal fins, which stabilize the large fish.
The anal and pelvic fins play the same role.

2. They give the shark direction and propulsion.

The pectoral fins prevent the shark from pitching up and down, and moving all over unsteadily.
The paired pectoral fins lift the shark as it swims and prevent it from sinking.
The caudal or tailfin moves the shark forward.



Without fins a shark would not be able to swim, and thus survive. Sharks use their body and tail in a side-to-side motion to move through the water. This swaying movement gives the body a strong forward thrust. The pectoral fins are drawn down at a slight tilt permitting the shark to rise up. If it tilts its pectoral fins and curves its body, it can turn quite easily. If it needs to slow down, it just puts on the brakes by angling its pectoral fins and pushing against the water.

FUN FACT - Sharks have pelvic fins and pectoral fins where many animals would have front and back legs.

Amazingly enough, some sharks - such as the great white - move so fast that they can generate enough force to jump right out of the water. One has to admit this is a beautiful sight and it is a wonderful skill to enhance hunting!

SHARK FIN SOUP AND SHARK ENDANGERMENT

Sharks are threatened by an increasing demand for shark fin soup, which is considered a delicacy in some countries. This is one of the greatest pressures on shark populations. Sharks are pulled from the water to have their fins sliced off while they are still alive, and then thrown back into the ocean to slowly die.

5. Shark Teeth

There is something unique about sharks' teeth! A shark without teeth could not survive; it would starve. Therefore, unlike many other animals, sharks continuously get new teeth to replace those that fall out. A shark's mouth generally contains five or more rows of teeth, one behind the other. All rows, with the exception of the first, lay flat in the animal's mouth. The next row rises up to replace any teeth that have fallen out or were broken. Sharks always make new teeth and have always spare rows of teeth.

FUN FACT - A big shark such as the lemon shark might get through 30,000 teeth in its lifetime!

Sharks' teeth are adapted to what they eat. Unlike humans, sharks do not chew. They are not omnivores, but carnivores.

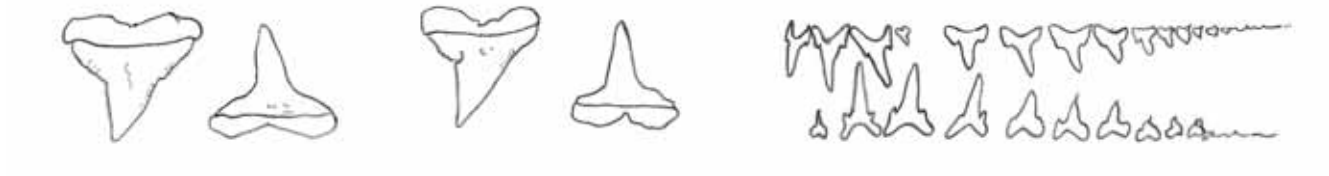
They use their teeth to grasp prey and, if needed, tear the prey into smaller chunks they can swallow.

Most shark teeth are very sharp. Sharks' jaws are powerful and the sharp teeth are capable of cutting through bone and even thin steel chains.

Shark teeth vary from being ferocious-looking curved spikes to flat triangular points, to points that are so small that they are not used for anything at all. The larger sharks, like the great white and the tiger shark, have triangular teeth with jagged edges.

This helps to keep hold of large fish and animals so as to tear chunks of meat from their bodies or slice through a turtle's shell.

A sand tiger's teeth, on the other hand, are long and narrow which make them look frightening, but in fact this type of shark is not very aggressive. The shape of its teeth is ideal for grabbing hold of slippery prey, like fish and squid.



However, the whale shark, one of the biggest sharks on earth, has very small teeth. Whale sharks don't use their teeth for biting because they simply filter their food.

6. Shark Senses

Sharks have amazing senses. They use these well-developed senses to avoid predators, to hunt for prey and to reproduce. They can see, smell, taste, touch and hear. On top of that, they have a sixth sense! They can pick up tiny electrical impulses in the water. As all animals produce some type of electrical signal, this can be very useful in detecting their prey.

a. Vision

Sharks have quite exceptional eyesight and their night vision is quite good. They can see ten times better than humans can in dim light, making it possible to hunt early in the morning or late at night.

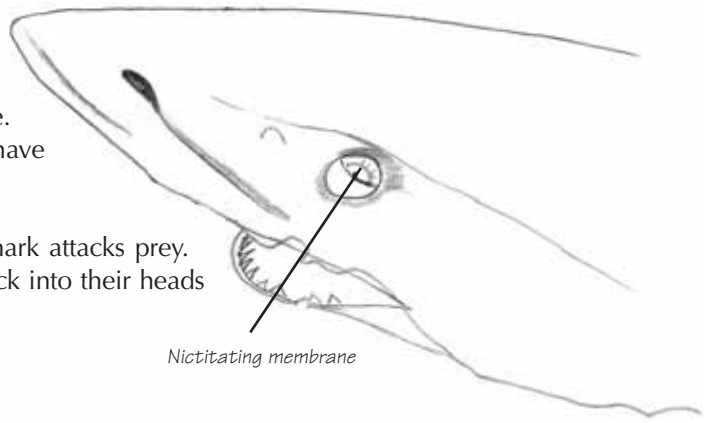
Sharks have a feature in their eyes similar to that of a cat. They have a mirror-like layer at the back of their eyes called a *tapetum lucidum*. This layer doubles the intensity of light coming in by reflecting light rays back to the retina, thereby making the most of available light.

Another advantage of the sharks' eyes is their ability to adapt to light. A shark can see as well during the day as at night. This is because a shark's pupils can dilate and contract thus controlling the amount of light coming in. One might think their world is black and white like other animals. However, they are capable of seeing different shades and some can even see in color. They really are the perfect predator.

Sharks' eyes are located on the side of their head, giving them a wider sight range than humans have. Some sharks that dwell near the bottom of the ocean have eyes on the tops of their heads. Sharks who are fast hunters see better than sharks that lay at the bottom of the sea ambushing their prey.

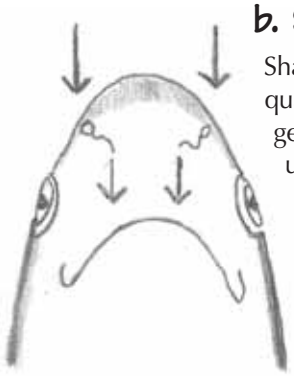
All sharks have a permanent eyelid, which stays around the eye. Some sharks, those who belong to the carcharhinidae family have a moveable eyelid as well, called a *nictitating membrane.*

This is a layer of skin that closes to protect the eyes when a shark attacks prey. Those that do not have this membrane simply roll their eyes back into their heads when they attack.



Nictitating membrane

b. Smell



Sharks also have a powerful sense of smell, which means they can detect odors in tiny quantities. A shark can smell a drop of blood from nearly two miles away. It can detect the general smell of fish and other animals. Note that sharks have a nose with nostrils, which they use exclusively for smelling and not breathing.

Most sharks use movement and smell to lead them to prey, and only rely on vision when they are up close.

Smell works from a distance but once the shark wants to test its potential food source it takes a bite. If it doesn't like it, it spits it out.

The nostrils are found on the sides of their snout.

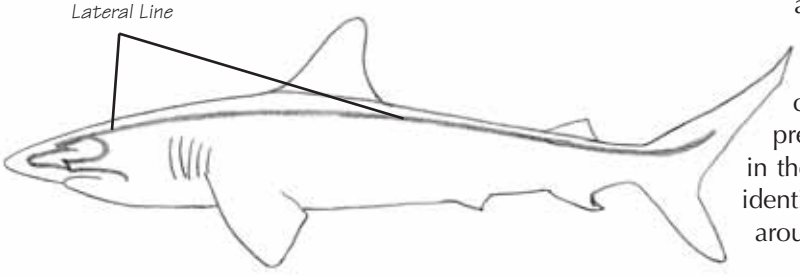
c. Taste

Sharks have a powerful sense of taste: they are picky eaters and do not eat what does not taste good to them, people, for example! And when they do sometimes eat tin cans, plastic bottles or bags, this is quite accidental. Besides tasting with their mouth, they also have taste-sensitive spots all over their bodies. A shark can rub up against another object and know what it tastes like. This would explain why sharks would bump into unknown prey instead of biting it. It is not trying to intimidate; it just wants a little taste!

d. Touch

Sharks have nerve endings under their skin that are sensitive to touch. This ultra-sensitivity is due to the shark's *lateral line.* All sharks are equipped with cells situated along a *lateral line,* which branch out in the head and stretch down the entire body. These cells can detect the slightest movement around them. In fact, they allow the shark not only to feel its own body and movements, but they also relate information about the water temperature, currents and all electrical signals in the water. So it is pretty easy for a shark to detect a fish thrashing around in the water. As well, this hypersensitivity allows them to identify threats, to meet their mate and to find their way around.

Lateral Line



e. Hearing

Sharks have an excellent hearing and detect sounds from very far away. Sharks have ears on both sides of their brain that are connected to the lateral line. We cannot see a shark's ears because they are situated inside their heads.

They hear deep, low-pitched sounds, like the motor of a boat and will sometimes be tempted to go and take a look. They can, of course, hear the poor hurt flopping fish as well as smell it. And divers cannot slip in the water unnoticed.

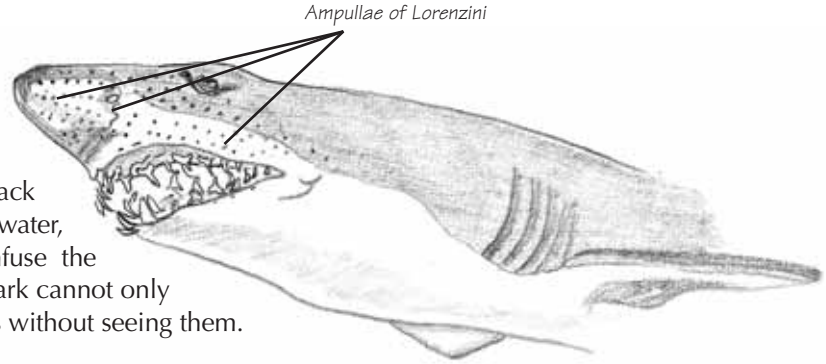
Sharks use sound to locate food. It is often the first sense a shark relies on to detect prey. Under water, sound travels faster and farther than on land. Sharks are attracted to low-frequency pulsed sounds, similar to those wounded or ill prey would emit. Most attractive sounds are in the frequency of 25 to 100 Hz. Some sharks are attracted to sound sources from distances as great as 250 m (820 ft.).

f. Electroreception - a sixth sense

Like many fish sharks also have another sense, a sixth sense, which we don't know much about. They are able to detect tiny electrical impulses in the water. As all animals produce some electrical signals this can be very useful! They can detect movement in the water from hundreds of meters away. They can pick up electrical signals generated by their prey, making it possible to feel other animal movements.

This sixth sense is made possible thanks to electro-receptive organs called *Ampullae of Lorenzini*. These were discovered only recently. The Ampullae are jelly-filled pores. These pores are located all around their heads with a greater concentration around their snouts and are connected to the brain through nerve endings.

Basically, these ampullae are electrical field-sensing devices. Every living creature produces an electrical field which sharks can detect.



Strangely enough, a shark will sometimes attack a metal object. This is because, in salty seawater, metal gives off electric signals, which confuse the shark into thinking it is prey. This means a shark cannot only detect its prey but a diver or potential hunters without seeing them.

FUN FACTS - Range of distances for sharks' sensory organs:

Touch & taste:	***contact***
Ampullae of Lorenzini:	***several feet***
Vision:	***dozens of feet***
Smell and Lateral Line:	***several football fields***
Sound:	***several miles***

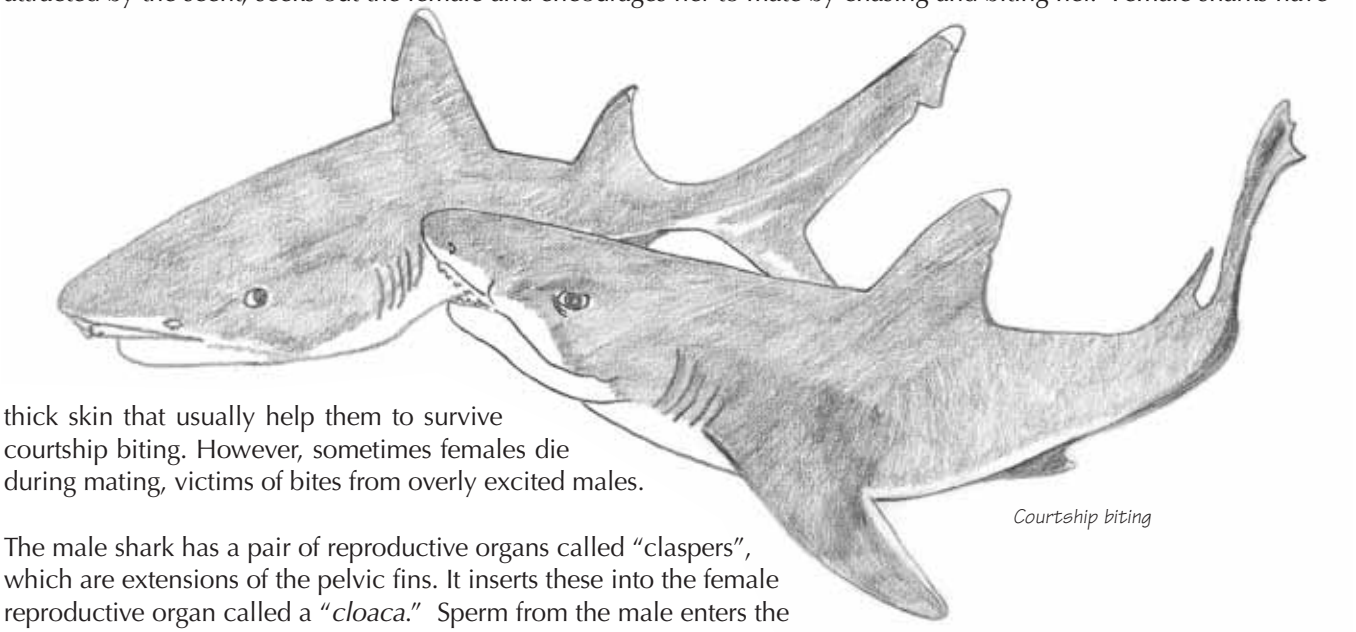
7. Shark Reproduction

Most shark species grow slowly and take many years to reach maturity. The larger sharks usually mature in six to eighteen years, or longer. Scientists have difficulty determining sharks' longevity. Certain large shark species can live to the age of forty, or perhaps longer. Sharks have long reproductive cycles (one to two year long for many sharks), as well as a long gestation period. Gestation lasts from three to four months in small sharks to two years and longer for larger sharks. They have also a low fecundity rate. The number of embryos born to a single mother varies from two (sand tiger) to several hundred (whale shark). This is a very low fecundity rate in comparison with other fish.

Slow maturation, low reproduction rates, low fecundity, and long gestation periods make sharks very vulnerable to over-fishing.

While some sharks give birth on the deep ocean floor, many sharks give birth in coral reefs, in shallow coastal waters, or estuaries, i.e. where there is a lot of food. These are the very places that attract fishermen. Fishing can remove them from the ocean before they have time to reproduce. Furthermore, any environmental degradation of these areas threatens their nursery areas.

During the mating process, the female shark releases perfumed chemicals into the water. The male shark, which is attracted by the scent, seeks out the female and encourages her to mate by chasing and biting her. Female sharks have thick skin that usually help them to survive courtship biting. However, sometimes females die during mating, victims of bites from overly excited males.



Courtship biting

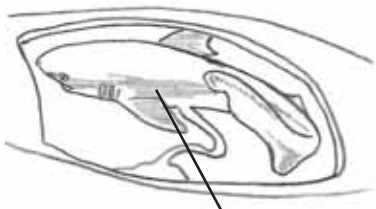
The male shark has a pair of reproductive organs called "claspers", which are extensions of the pelvic fins. It inserts these into the female reproductive organ called a "*cloaca*." Sperm from the male enters the female and swims to an egg inside one of her two uteruses. The eggs are fertilized inside the female's body.

Baby sharks are called "pups". Most are born with a full set of teeth and are ready to take care of themselves immediately. In fact, they quickly swim away from the mother shark that might decide to eat them. A litter size ranges from one or two pups to over 100.

Fertilized eggs develop in three different ways depending on the shark species. 70% of sharks have live births: "viviparity" and "ovoviviparity." 30% of sharks are "oviparous," which means they lay eggs.

a. Viviparity

The embryo stays inside the mother's body and attaches itself to the uterine wall to develop. There is a placenta, which gives nutrients and oxygen from to mother to the embryo.

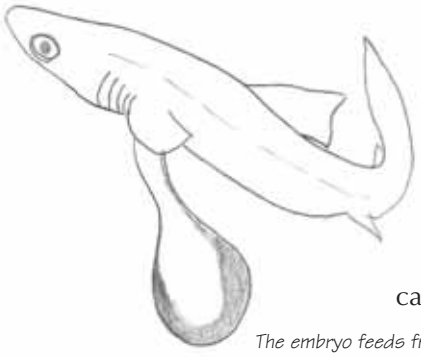


Embryo

The embryo receives the nourishment from the mother's blood via an umbilical cord connected to the embryo near the pectoral fins.

After a 9 to 12-month period of gestation, the mother gives birth to live pups. When the formed pups are born, they come out of the mother tail first. This protects the pup's head during birth. The pup already knows how to swim. It is not dependent on its mother and looks after itself immediately.

Watch Out! Most of the scalloped hammerheads seen in SHARKS are pregnant females!



b. Ovoviviparity

The embryos form inside an egg in the womb. There is no placenta to nourish them and they get food from a liquid called "yolk" stored in a sack or pouch attached to their body.

Once the yolk is used up, the embryos eat any unfertilized eggs and the smaller, weaker pups. Very few pups survive until birth due to this form of sibling cannibalism.

The embryo feeds from the yolk sack attached to its belly

c. Oviparity

The mother deposits her eggs in the ocean. The embryo grows inside the egg and emerges when fully developed. Shark's eggs can come in various different shapes and sizes. Most of them are shaped like pouches with strong cases to protect the developing baby.

After depositing her eggs, the mother shark does not care for the eggs, so baby sharks are exposed to many dangers. But mother sharks deposit their eggs where they will be safe and where there is a good supply of food to be eaten when the baby shark hatches.

Further information on the reproduction patterns pertaining to each species featured in ***SHARKS*** *can be found in the "For Educators Only" section of our website* ***www.sharks3D.com***. See the file entitled "***The Cast of SHARKS."***

Developing embryo within egg

UNIT I
Activities: What do you know about sharks?

How much do you know about sharks' anatomy? Before going to see the movie, you might want to test your own knowledge by doing the following activities. You should answer questions before and after the screening.

Activity # 1 - True or False?

	TRUE	FALSE
1 - Sharks have a skeleton made of bone.		
2 - When a shark loses or damages a tooth, it is replaced by a new one.		
3 - Sharks cannot hear anything.		
4 - The largest shark has very tiny teeth and does not bite or chew.		
5 - Most sharks have to swim continuously in order to breathe.		
6 - Sharks live only in the Atlantic Ocean.		
7 - Sharks have lived in the oceans for 50,000 years.		
8 - Sharks can smell a drop of blood in the water from very far away.		
9 - Most sharks' eyes are located on top of their head.		
10 - Without their fins, sharks cannot survive.		
11 - Like humans, sharks have 5 senses: touch, smell, taste, sight and hearing.		
12 - Sharks have a nose but do not breathe with it: they smell.		
13 - The dorsal fin is found on the shark's stomach.		
14 - Sharks are very sensitive to low frequency sounds.		
15 - Sharks cannot see well under water.		
16 - Some sharks' eggs hatch inside the mother's body and the babies develop inside her uterus like mammals.		

Activity # 2 - Drawing a shark

Draw one or two of the sharks in this manual or in another book. Photocopy the drawings. Blow them up to larger sizes and copy the reverse image of each shark. Color your sharks, then cut them out and staple them together. Before closing completely, stuff with recycled paper. Hang them from the ceiling and transform your classroom into an underwater shark park.

Activity # 3 - It makes sense

Compare your human senses with sharks' senses. Imagine you are a shark (and explain how you would use your shark senses to get food. Imagine that you are a hammerhead shark and try to explain what you see and how you taste food.

Activity # 4 - It's KWL time!

Take out your pencils and fill in the KWL Chart.
Complete the K (what you KNOW) and W (what you WANT to know) parts of the worksheet before going to see the movie **SHARKS**. After viewing the movie, complete the L (LEARNED) part of the worksheet.

SHARKS WORKSHEET		
K What you know.	**W** What you want to know.	**L** What you learned.

UNIT II
Sharks: Challenging prejudices

This unit is designed to challenge many false ideas that people have about sharks and explain how they really behave. Sharks are thought to be big, fierce and mean animals, that love eating a lot, and enjoy human flesh! In fact, sharks tend to eat creatures quite a bit smaller than themselves and humans do not tempt them. Still, they are some of the largest animals on coral reefs and in the oceans, and they are at the top of the food chain, exerting a balance and a control over the complex webs of life below them.

In the ocean, fish and sea creatures depend on each other for survival. The constant eating and being eaten creates a circle of life where everything is recycled and nothing is wasted. Without sharks or other top predators that eat smaller fish, there would be no control of fish populations. Those would quickly outgrow their food resources. Sharks are playing a crucial role in the oceans in maintaining the balance of the food chain. Furthermore, sharks eat injured or sick animals, thus getting rid of the weaker individuals. They are actually cleaning the oceans and thus keeping the ecosystem healthy.

1. What do sharks eat?

All sharks are flesh-eaters. Most sharks eat fish and other animals. Depending on the species, squid, octopus, lobsters, sea otters, turtles, etc. are quite popular. However, the whale shark, the largest shark of all and the largest fish on earth, eats nothing but tons of plankton!

Despite all the stories, sharks don't eat people!

Sharks and other predatory fish with big teeth are generally quite safe - even large sharks feed on much smaller creatures than us, but they will bite if provoked, or in very unusual circumstances when there is a lot of blood or bits of fishes in the water where people are fishing. More than half of the world's sharks never grow to be more than 1.20 or 1.50 m (4 or 5 ft) long and many have teeth too small to cause serious injuries.

Surprisingly, sharks don't eat all that much, and some can go for weeks without eating anything. Sharks that are active hunters may only eat several times a week while sharks that feed on small prey eat a few times a day.

2. What about shark attacks?

Mankind has given sharks a bad reputation as "ruthless, vicious killers" and this remains the idea of sharks that most of us keep in mind. The media do their best not to go against this misconception.

Statistically speaking though, sharks do not present such a great danger for humans. Of course, many sharks are potentially capable of killing people, but there is an average of twelve fatal shark attacks on humans per year; it's fewer than the number of people killed by dog bites, or bee stings, or hit by lightning or even slipping in a bathtub!

Most sharks' first reaction to an unfamiliar "animal," such as a human, in their habitat will be one of self-preservation; they will swim away.

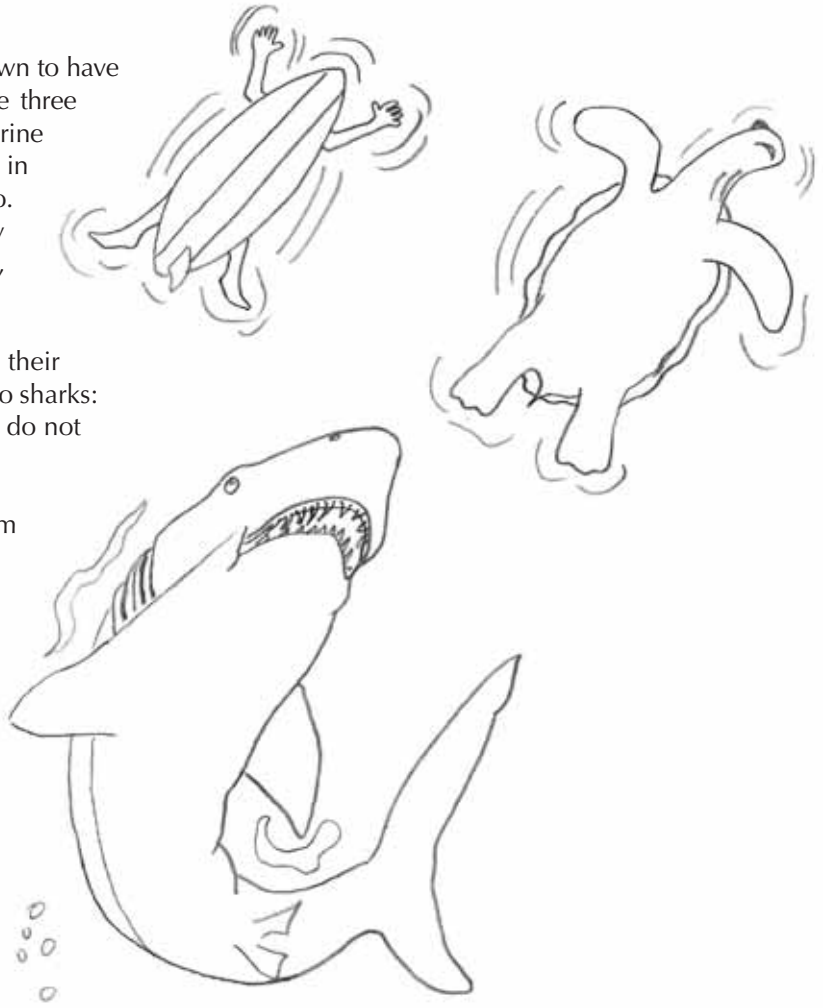
Of the 400 species of sharks, only about 20 are known to have ever attacked humans or boats. These species have three features in common: they prey on fish or marine mammals, grow to a large size, and hang around in warmer coastal waters where people also often go. Humans become prey by accident. A shark may mistake swimmers or divers for prey. From below, surfers do look like turtles or seals.

Once the shark have attacked, they usually realize their mistake and swim off. Humans are not appetizing to sharks: we are too bony, and unlike seals, for instance, we do not have enough meat or fat on us.

Sharks may also injure victims by bumping them vigorously.

On coral reefs, there is such an abundance of smaller fish that direct attacks on people are almost unheard of. The few reported cases involve people who, while spear-fishing, had released lots of blood into the water. Most shark attacks involve people handling hooked or trapped sharks.

Shark attacks are occasionnally deadly but one must remember that they are very rare. Most reported shark attacks have been in the ocean around North America, Australia and South Africa. The warm water in these places attracts large numbers of people, bringing them into possible contact with sharks. Divers sometimes provoke a shark by pulling its tail for fun. This makes the shark very angry and it becomes especially dangerous. Plus, the more people are diving, the more attacks there are.



Similarities between a surfer and a turtle from a shark's point of view…

3. How do sharks get their food?

A. Hunting

Sharks are the world's most ancient marine predators. They have larger brains than most other fish and they are sophisticated hunters with spectacular senses. Sharks' hunting habits remain fairly mysterious. They travel quickly over long distances and swim down to depths where it is difficult for man to go. For the most part, they are solitary animals. They typically live and hunt by themselves. Their survival is based on finding food and staying healthy in the process. Although they may swim around with sharks of their own species, most sharks wait until they are alone to attack.

Sharks are known as "silent hunters" because they often sneak up on their prey. Many sharks rely on camouflage in order to have an element of surprise. They wait for the right moment to come up from behind or from underneath and attack. Once a shark has found a potential meal, it will circle it at some distance, sizing up the situation. When it is ready, the shark moves in quickly and gets a good bite before the prey even knows what has happened. Most times, one bite is sufficient to bring down the prey, after which, they wait for it to die from loss of blood. This method of hunting saves a lot of energy.

DID YOU KNOW?

Sharks rely on camouflage to surprise their prey when hunting. Sharks are generally dark on top, their dorsal side, and lighter on the bottom, their ventral side. Preys or predators looking down don't always see them against the dark background of the ocean bottom. However, if a prey or a predator looks up from below, the light bottom of the shark blends in with the lighter surface of the ocean where the sun shines so it can avoid being seen. Similarly, the sharks that prefer the bottom of the ocean blend in perfectly with the seabed.

B. Filter feeding

Some sharks catch their dinner by swimming with their mouths open. They suck in water, sifting their food from it. Their meal consists of the smallest organisms around, i.e. the tiny animals and plants called "*plankton*" floating in the water. This way of eating is called *filter feeding*. Ironically three of the biggest shark species filter food, the megamouth, the basking shark and the whale shark.

C. Other strategies

Sharks do not always hunt for food. Like other large predators such as tigers, they seek out easy meals, i.e. injured or sick animals. They are also scavengers that eat whatever dead creatures they find as long as they taste good to them. Some camouflaged bottom dwellers blend in with the ocean floor and wait for their prey to come along. When a fish gets close enough, the shark opens wide and swallows the fish whole.

FEEDING FRENZY

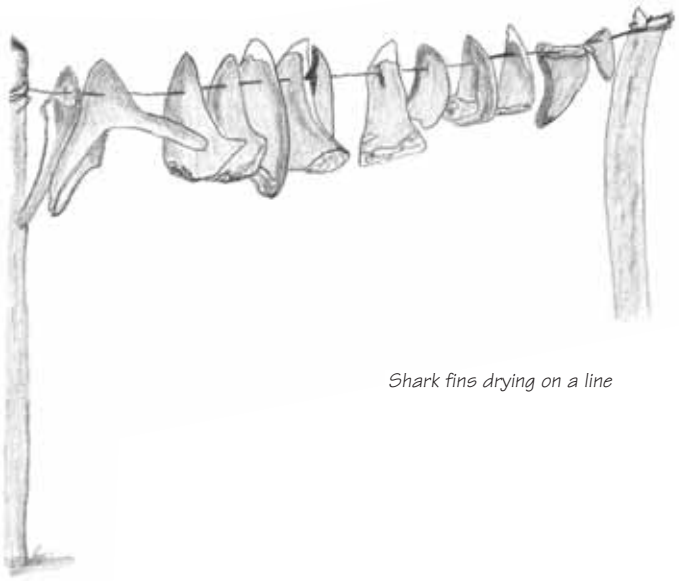
In one of the sequences of the film, you will witness a "feeding frenzy". One gray reef shark catches hold of a fish. The smell of blood in the water attracts others sharks, who go wild trying to snatch away the piece of fish. Too many chemical signals are going through their brains and they attack anything that moves. The whole think is over in a few minutes. Suddenly, everything is over, and sharks glide away.

4. Sharks in Danger

For 400 million years sharks have survived enormous environmental changes, and yet evolution didn't prepare them for the super-predator that would appear in only the last 50 years: industrialized man.

Some types of sharks are in danger of being extinct such as all the sharks and rays that appear in **SHARKS**. By slaughtering these animals, man is threatening the important role they play in maintaining the balance of life in the oceans.

Humans may be afraid of this ocean dwelling predator but sharks have more reasons to fear humans. Humans are now devastating the world's shark populations.

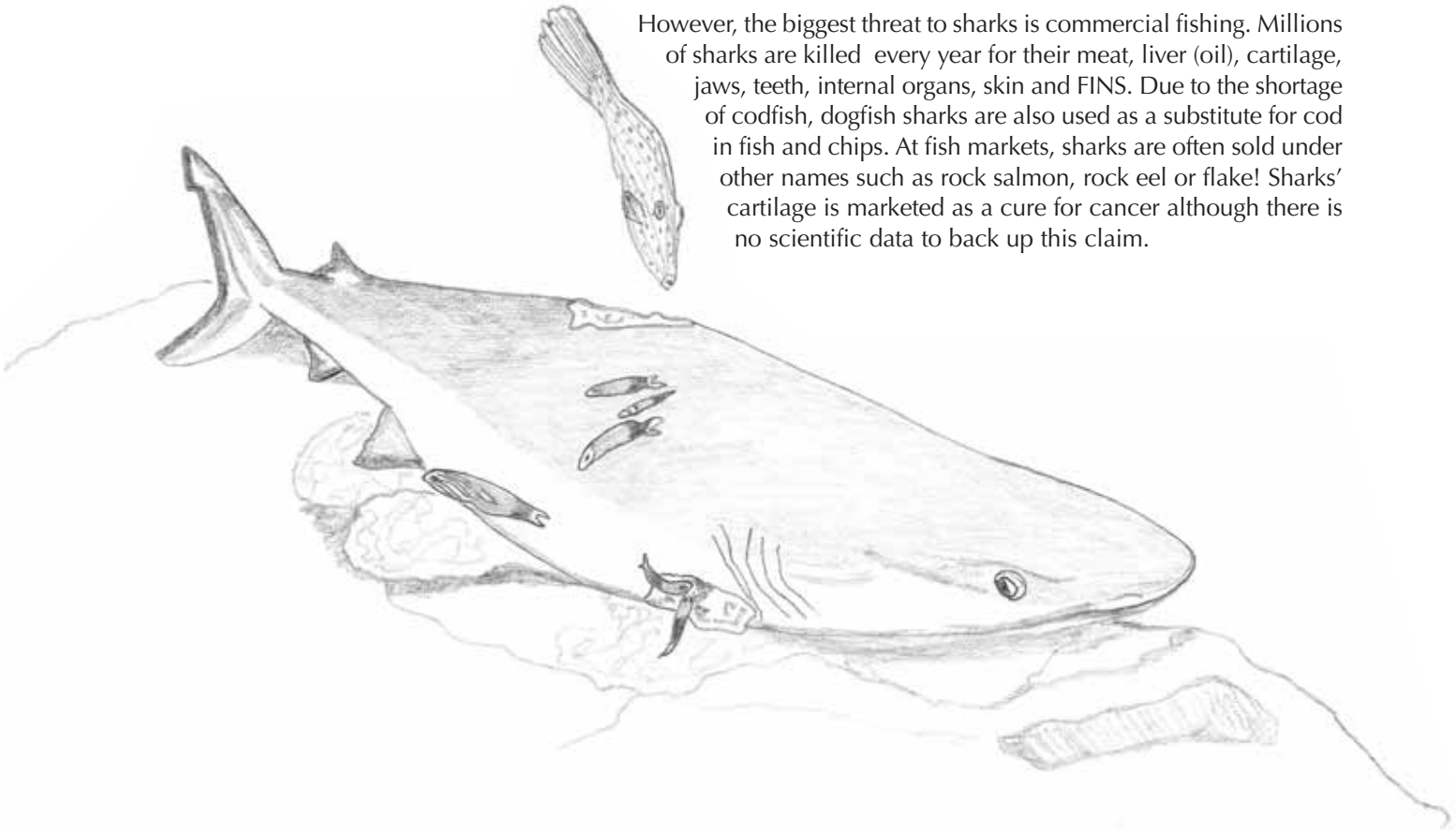


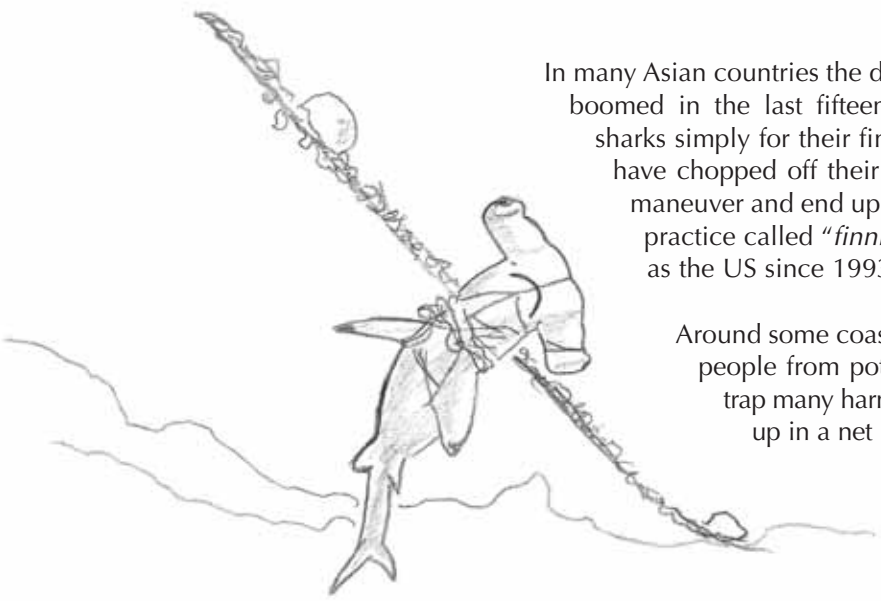
Shark fins drying on a line

100 million sharks a year are being slaughtered worldwide.

Sharks are the targets of sport fishermen. Since sharks remain difficult catches, when a hunter accomplishes his goal, he often displays the jaws with their teeth as souvenirs or sells them to tourists.

However, the biggest threat to sharks is commercial fishing. Millions of sharks are killed every year for their meat, liver (oil), cartilage, jaws, teeth, internal organs, skin and FINS. Due to the shortage of codfish, dogfish sharks are also used as a substitute for cod in fish and chips. At fish markets, sharks are often sold under other names such as rock salmon, rock eel or flake! Sharks' cartilage is marketed as a cure for cancer although there is no scientific data to back up this claim.





Hammerhead caught in a fishing net

In many Asian countries the demand for the very popular shark fin soup has boomed in the last fifteen years.This means that fishermen will hunt sharks simply for their fins throwing them back in the water once they have chopped off their fins. Without their fins, sharks are unable to maneuver and end up sinking to the bottom of the ocean to die. This practice called "*finning*" is only forbidden in some countries (such as the US since 1993).

Around some coastline countries *safety nets* are set up to protect people from potentially dangerous sharks. However, the nets trap many harmless sharks as well, and once a shark is tangled up in a net it has little chance of escaping.

Another cruel death for sharks is getting caught in *fishing nets.* Huge nets are laid out to catch tuna but they end up catching other ocean dwellers like sharks and dolphins. They are unwanted catch, called *"by-catch"*, and are usually thrown back in the sea. Yet, most of them are already dead.

About half of all sharks taken are caught by accident as by-catch in fisheries targeting other species.

Sharks are particularly vulnerable to *overfishing* because of their low reproductive rates. They mature late, grow slowly and produce relatively few young in comparison with other fish. Reaching breeding age may take up to 6 years for some sharks. The gestation period (time spent by the embryo inside its mother) can be up to 22 months with some sharks. Fishing can remove them from the sea before they have had time to reproduce.

Destructive fishing practices such as blast and poison fishing are also endangering sharks. Some fishermen pour cyanide - a powerful and rapid-acting poison - into coral reef cracks, where fish live. The cyanide stuns the fish, making it easy to capture. But this practice poisons the coral reef and is, of course, extremely harmful to all the animals and other organisms living there. Other fishermen use explosives to catch fish. By creating a massive blast, they kill all the fish, including sharks, over a large area. This is terribly wasteful, and the blast also destroys the coral that is home to many sharks and other sea creatures. It will take years for the reef to recover and the fisherman will leave nothing but destruction.

Sewage, industrial waste, pollution, careless tourism, deforestation and massive energy consumption leading to global warming are some of the other man-made elements that threaten the coral reefs, thereby endangering the many sharks and other sea creatures living there.

People have been overkilling sharks and thus have thrown underwater ecosystems out of balance.

Today, up to 80% of sharks are threatened by extinction.

UNIT II
Activities: Challenging prejudices

Activity # 1 - True or False?

	TRUE	FALSE
1. Most sharks are large creatures.		
2. Sharks like human flesh.		
3. Sharks only eat big animals.		
4. The great white shark is the largest shark in the world.		
5. The whale shark eats seals and squids.		
6. A feeding frenzy is when sharks eat each other.		
7. Sharks are scavengers.		
8. Humans are killing more sharks than sharks are killing men.		
9. Like most fish, sharks have many babies.		
10. Sharks kill for fun.		
11. The largest fish in the world is the whale shark.		
12. The manta ray has a torpedo-like shaped body.		
13. Sharks are buoyant because of their over-sized gallbladders.		
14. The dorsal fin is found on the shark's stomach.		
15. Sharks are very sensitive to low frequency sounds.		
16. Bees kill more people per year than sharks do.		

Activity # 2 - Shark Tales

Get together with 2 or 3 students and find
- as many films or stories or legends you know about sharks.
- as many expressions you know containing the word “shark”.

The group that finds the most answers is the winner.

Activity # 3 - Shark Reputation

Get together with 2 or 3 students and discuss the following topics:

a. Explain what type of reputation sharks have and if it is justified.
b. Explain why you think humans are scared of sharks.

Activity # 4 - Dangerous Human Activities

Get ready to discuss how some of the human activities listed below are dangerous for sharks.
- Litter - marine animals get tangled in plastic or choke on trash.
- Pollution - industrial waste
- Over fishing - throwing the ecosystem out of balance
- Destructive fishing practices such as explosion, cyanide, etc.
- Fishing: danger due to longliners, nets, anchors.
- Swimming: danger caused by nets set up to protect swimmers from sharks.
- Human consumption: shark fin soup, fish and chips made with shark meat.
- Climate warming due to energy consumption.

UNIT III
The Cast of SHARKS

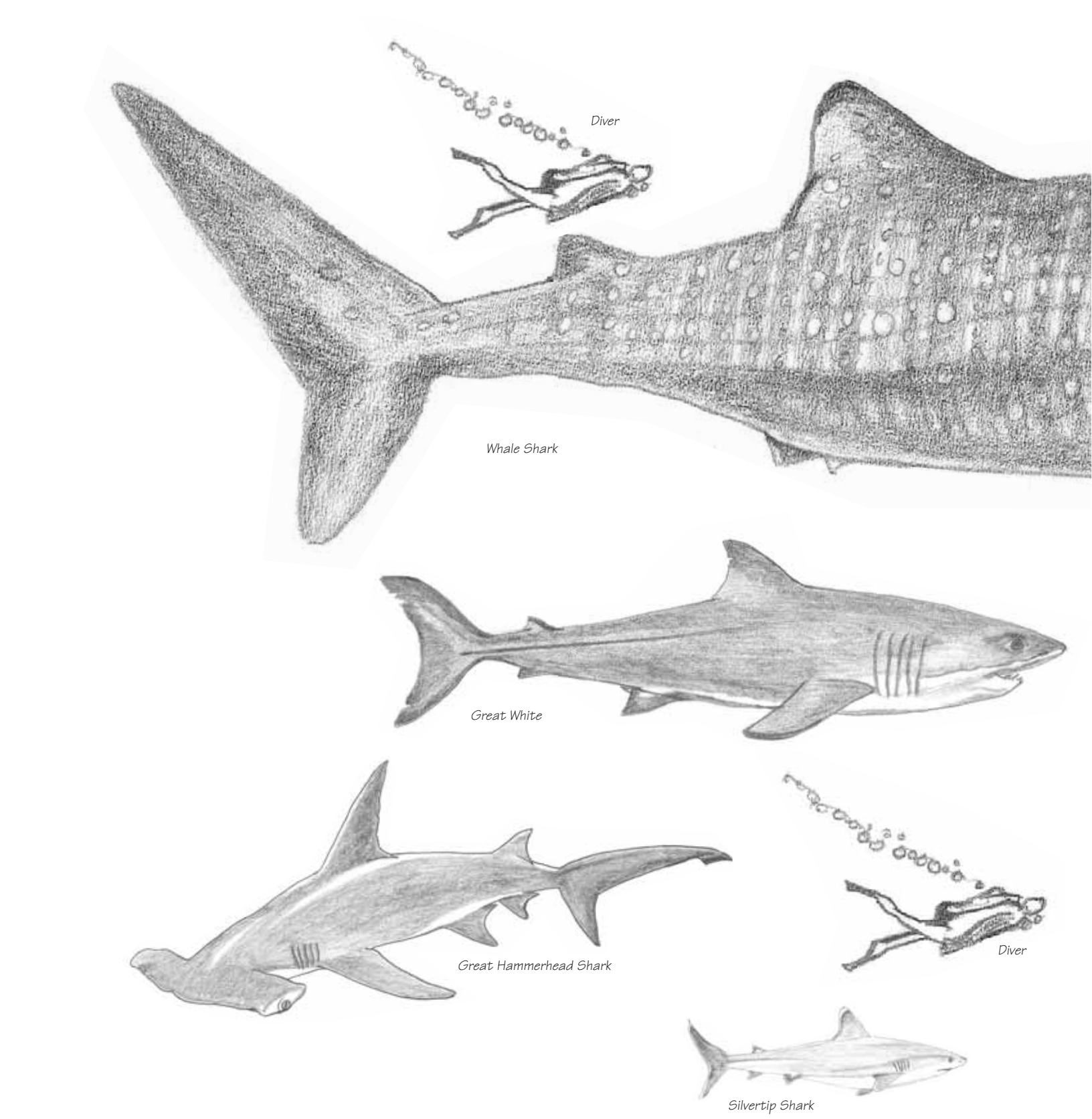
1. The Cast

In **SHARKS** you will discover seven different species of sharks: *sand tiger shark, silvertip shark, great white shark,* s*calloped hammerhead shark, gray reef shark* and *whale shark*. You will even see a solitary *great hammerhead* picking up a dead female reef shark. You will also encounter two relatives of the shark: the *giant manta ray* and the *sawfish*, a fish not to be confused with the saw shark. You will swim with a mother *dolphin* and her baby while surrounded by threatening sharks. You will also accompany *sea lions* in their joyful games.

Throughout **SHARKS**, you will be guided by our wise friend, the humorous *turtle* we like to call "Aris Turtle."

The file **"The Cast of SHARKS"** in the **"For Educators Only"** section of our website **www.sharks3D.com** describes each species featured in **SHARKS**, presenting some of its most important characteristics, such as average size, behavior (social, territorial, schooling, aggressive, gentle, etc.), fins, coloration, feeding habits, habitat, reproduction, potential danger to humans, endangered species.

	AVERAGE	MAXIMUM
Whale shark	12 m (39 ft)	up to 18 m (60 ft)
Giant manta ray	7 m (22 ft)	up to 9 m (30 ft)
Great white	6 m (20 ft)	up to 6.8 m (22.3 ft)
Large tooth sawfish	5.5 m (18 ft)	up to 6.5 m (21 ft)
Great hammerhead shark	3.5 m (11.5 ft)	up to 6 m (20 ft)
Sand tiger shark	3 m (10 ft)	up to 3.6 m (12 ft)
Scalloped hammerhead	2.5 m (8.2 ft)	up to 4.2 m (13 ft)
Gray reef shark	2 m (6.6 ft)	up to 2.6 m (8.4 ft)
Silvertip shark	2 m (6.6 ft)	up to 3 m (9.8 ft)



Scale: 1cm = 0,5m

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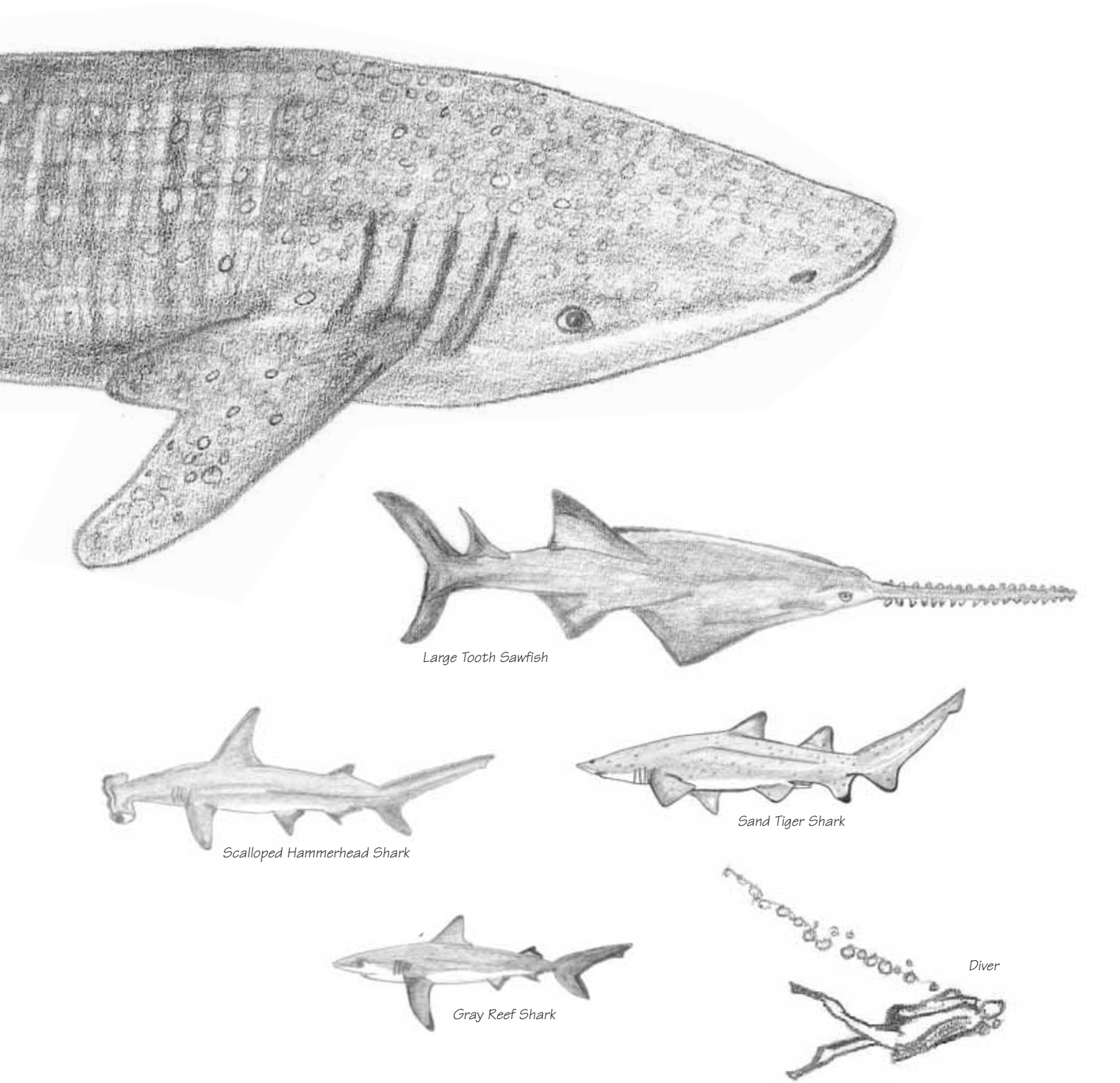
Large Tooth Sawfish
Scalloped Hammerhead Shark
Sand Tiger Shark
Gray Reef Shark
Diver
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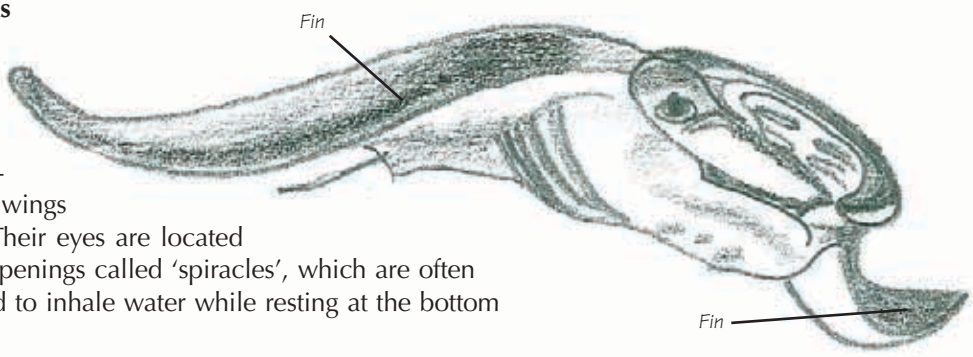
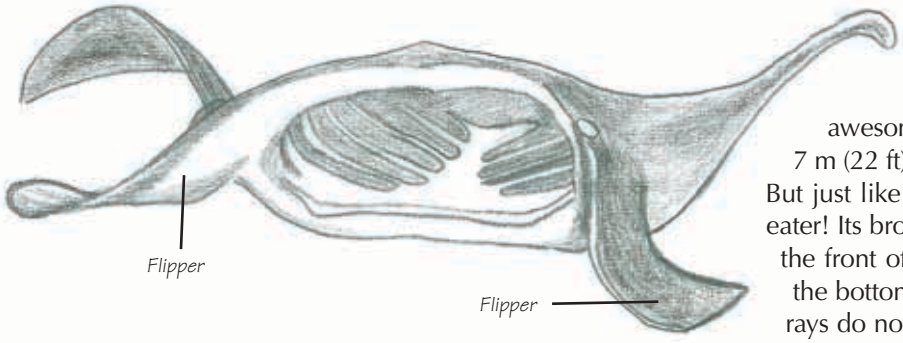
2. Giant Pacific Manta Ray

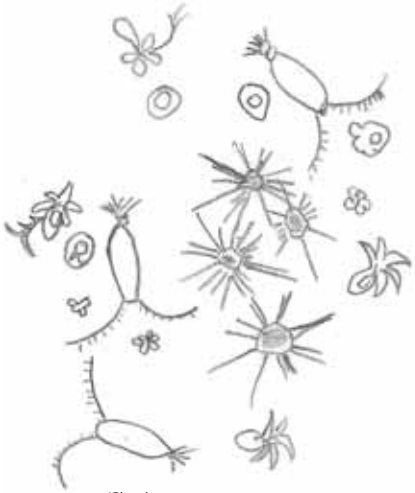
Rays belong to the same family as sharks. However, like some relatives, they do not look alike. Rays have a flat body shape with an enormous wingspan. In fact, their triangular-shaped pectoral fins look like wings and lead right up to the head. Their eyes are located laterally. Behind each eye are openings called 'spiracles', which are often mistaken for ears. These are used to inhale water while resting at the bottom of the ocean.





The **Manta ray** is the largest type of ray weighing in at 1,350 tons (3,000 lbs). It is awesome looking and has a wingspan of nearly 7 m (22 ft), that is wider than 4 cars next to each other. But just like the largest sharks, it is a harmless plankton eater! Its broad, rectangular terminal mouth is located at the front of its head and holds extremely tiny teeth on the bottom jaw. Because they are filter feeders, manta rays do not need large teeth.

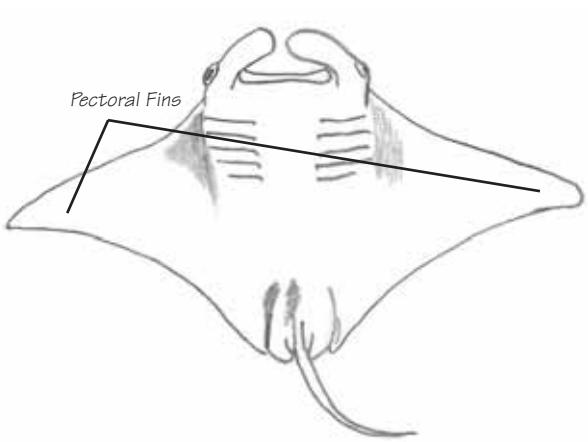
Did you know?
Plankton is a term that describes thousands of different types of microscopic creatures, which drift in the water. It includes certain types of algae, which are plants and use the suns energy to create food. These are called phytoplankton. It includes also lots of animals, or larvae, which eat the phytoplankton, and even eat each other - these are called zooplankton.

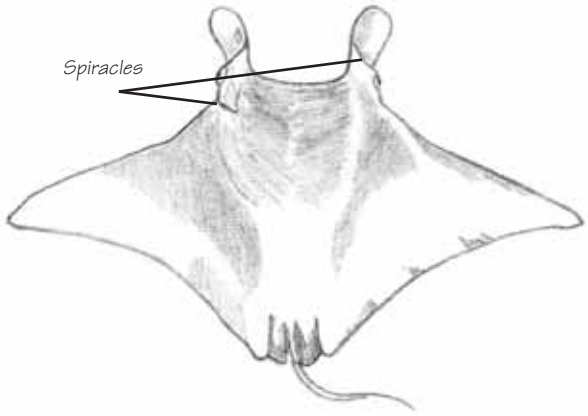


Plankton

Manta rays have a small dorsal fin on their backs, just above the tail. Their tails do not have a spine and are slightly flattened.

Behavior - A big difference between mantas and sharks is the way they swim. A manta ray flaps its pectoral fins up and down like wings. They are very powerful swimmers that can leap up out of the water and somersault if they want. They have been seen to jump more than 6 meters (20 ft) out of the water. The manta ray is a large fish and likes to swim alone, but will swim in loose aggregations.





Habitat - The manta is found worldwide in temperate, tropical and subtropical waters. Being a plankton eater, the manta is normally found at the surface of the ocean. However, it also swims in mid-waters near reefs, offshore islands and even near the seabed. The Manta Rays in **SHARKS** were filmed off the Socorro Islands, Mexico.

Reproduction - Mantas reproduce through ovoviviparity, which means that the eggs develop in the female's body. Since there is no placenta to feed them, the embryos eat the other eggs and each other. As a result very few pups are born. The manta gives birth to one or two pups at a time. Unfortunately, young mantas are easy prey for larger sharks, so it is a good thing they grow quickly.

Potential Danger to Humans - They are harmless to humans.

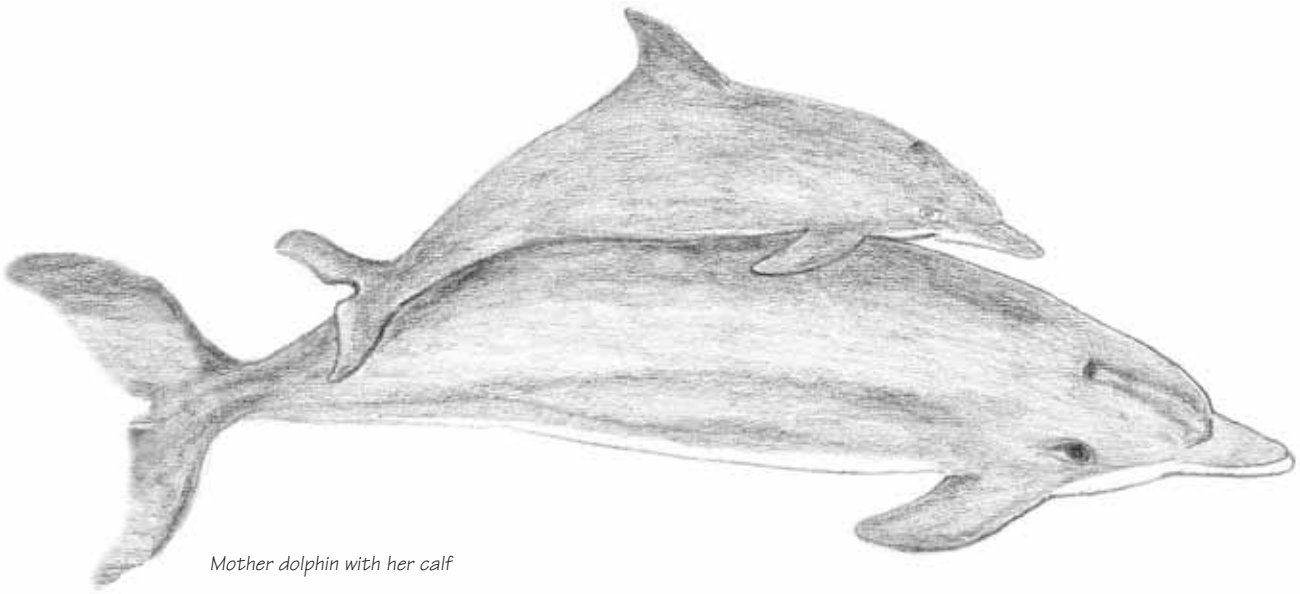
Endangered - For a long time, the manta ray was known as the "devil fish." This is probably because of its enormous size and the horn-like appendages on either side of its head. The word "manta" is Spanish and Italian for "cloak," which is quite fitting for the manta ray's shape, as it looks like a spread-out cape. As stated, mantas are harmless to man and rather indifferent to divers. However, their meat is considered a delicacy in some countries. The liver is also cherished and even its skin is used as an abrasive.

PIGGY-BACKING FISH!

Like the silvertip shark, the manta ray often has companions. In SHARKS you will witness a remora fish "piggy-backing" on the big manta ray! Remora attach themselves to sharks and rays with the flat suction disk on top of their head. They ride sharks' hydrodynamic bow wakes. In addition, they finish off leftover fish as well as eat the parasites off the manta. So it is a win-win symbiotic relationship.

3. Dolphins

Dolphins are mammals, not fish. This means that they are warm-blooded, breathe air, bear their young live, and nurse them. The thick layer of fat under their skin allows dolphins to maintain their body temperature at 37°C (98.6°F).



Mother dolphin with her calf

The dolphin must hold its breath while under water and return to the surface to breathe. If for any reason they would be unable to get air, they would drown, just as we would. Dolphins are able to hold their breath for up to 15 minutes. They must also be conscious to breathe. This means that they have a very peculiar way of sleeping. If they ever went into a full deep sleep like we do, they would die. According to some scientists, just one half of a dolphin's brain sleeps at a time.

Dolphins can be between 1.65 and 4 m long (5.4 to 13 ft), and weigh between 70 and 375 kg (154 to 827 lbs). Like sharks, dolphins are very streamlined and are capable of moving very quickly through the water. They regularly swim at 30 km/hr (19 miles/hour), but can swim as fast as 48 km/hour (30 miles/hour). They can do acrobatic figures and have been seen jumping over 6 meters (20 ft) in the wild.

DID YOU KNOW?

Dolphins are descended from land animals, but millions of years ago their ancestors went back to the ocean and learned to swim. Slowly, their legs evolved into flippers. If you take an x-ray of a dolphin's front flipper, you will see many of the bones you might expect to see in a hand! Most parts of their bodies transformed to adapt to ocean life. Nonetheless, they remain air-breathing animals.

Dolphins are predators. They are carnivorous and tend to eat small fish, but sometimes also chase squid or shrimps. Their incredible maneuverability allows them to sneak up quickly behind the fish and grab them with their small pointed teeth. Like sharks, they do not chew and swallow their prey whole.

Like sharks, dolphins have excellent **eyesight** and can see as well in open air as in water, even in dimly lit waters. One major difference between them and sharks is that dolphins do not **smell** underwater.

Like sharks, dolphins have a *sixth sense*, but theirs is called **echolocation**.
Echolocation is the emission of sound and the reception of its echo. The *clicking noises* a dolphin produces is echolocation, which, in fact, emit ultrasounds through the water. A dolphin's voice is very effective and can travel quite far through water. Water transmits sound extremely efficiently, and for a dolphin sounds are used to gather information for hunting, locating objects, animals and potential danger.

When the sound reaches an object, such as a fish, it bounces back towards the dolphins as an echo. The dolphin then knows where the fish is and how far away according to the amount of time it takes for the echo to come back.

Echolocation is extremely sensitive and dolphins can distinguish between very small objects at 15.2 m (50 ft) away. They can even use this ingenious sonar system instead of sight. It can come in real handy if they have to navigate in muddy water, down at the dark depths of the ocean.

It is rare to see dolphins underwater without hearing them. They make **lots of noise, clicking and squeaking.** It is thought that the squeaks are used as a form of communication. This is not language like humans use, but is still used to convey moods of excitement or alarm, or to direct activity in the group. Dolphins are nearly always found in groups. Groups of 1000 have been seen but it's usually more like ten to 100. When traveling in groups, it is very important that they can communicate and stay together.

All this communication, and the fact that dolphins have very large brains have led to a lot of discussion about how intelligent they are. Many dolphins have been taught complex tricks, and have even learned to mimic a few words, but there is very little evidence that they are more intelligent than, for example, apes. Their large brains may be necessary for their highly complex sonar systems, and their need to move fast and chase fish underwater.

Dolphins reproduce through viviparity, which means they bear their young live, like most mammals. Females give birth to one baby dolphin at a time after a gestation period of almost 12 months. Dolphins are very sociable animals, and other dolphins may stay close by to assist new mothers and protect them and their calf from sharks. In **SHARKS**, you will be able to witness a sequence where a large dolphin comes to rescue a mother and her pup surrounded by threatening sharks.

Mothering - Unlike shark pups, calves need their mothers. The mother dolphin nurses her calf for 12 to 18 months. She has to teach it how to breathe or else it will drown. Right after she gives birth, the mother has to quickly push the baby to the surface of the ocean. She does this by swimming under it and gently pushing it up and out of the water, where it can breath for the first time. It only takes this one demonstration for the baby dolphin to catch on, after that it knows exactly what to do.

Throughout its early life, the mother stays close and guides the calf's movements.

The mother dolphin has a unique voice and will whistle to her calf almost continuously for the first few days so it can learn her identity. This way if it wanders off by mistake, it can easily find her again. Plus, thanks to the 'hydrodynamic wake' created by its mother when she swims, a calf can keep up with the group. The baby swims close behind its mother and is carried by her slipstream. We can also observe this behavior in the sky when birds fly in a V-shape.

UNIT III
Activities - The Cast of SHARKS

Activity # 1 - Cross out Game

Cross out the animals that do not appear in the film **SHARKS**

Mako	Saw shark	Bull	Sting Ray
Silvertip	Sawfish	Sand tiger	Dwarf
Hammerhead	Great white	Dolphin	Nurse
Manta Ray	Lemon	Gray	Basking

Activity # 2 - The Food Chain: Who eats what?

In order to better understand the role of sharks in the ocean, you must first understand what a food chain is. In the oceans fish and sea creatures depend on each other for survival. The constant chain of eating and being eaten creates a circle of life where everything is recycled and nothing is wasted.

On land, even near us, grasshoppers eat grass, birds eat grasshoppers, and cats eat birds. This is called a **food chain**. In many places there can be a choice of items on the menu and we can draw lots of different food chains, all of which might go on at the same time. For example mice, or raccoons also sometimes eat the grasshoppers before the birds can, and then a wolf might eat the raccoon or a fox might eat the mouse. It all works the same in the ocean.

Assign a variety of sea animals to the following different levels of food chain:
- Primary producers: algae, sea grasses, phytoplankton, and microscopic organisms.
- Primary consumers or herbivores: zooplankton, filter feeders, and grazers.
- Carnivores: small and large organisms, including sharks, dolphins, and many fish.
- Omnivores: eat a mix of plants and animals. Humans are omnivores, and so are turtles.

Talk about **ways of catching food**: filtering, digging, chasing, ambush, and scavenging. Assign the sea animals appearing in **SHARKS** to these categories.

Activity # 3 - Word Find

H	L	D	L	V	U	O	K	Z	L	X	A	A	S	G	B
W	M	S	O	R	E	G	I	T	D	N	A	S	B	R	I
T	R	F	E	J	I	U	M	N	K	U	M	Y	V	E	C
G	R	A	Y	S	H	A	R	K	E	W	I	M	O	A	N
I	E	E	V	L	N	B	D	D	T	H	S	N	Z	T	E
O	F	I	H	T	A	L	R	S	O	A	U	E	C	W	R
E	M	U	A	L	S	L	A	C	L	L	A	N	T	H	N
N	M	K	M	Z	I	I	N	Z	M	E	P	P	L	I	U
O	T	A	M	D	P	E	L	F	V	S	X	H	Q	T	S
T	H	L	E	A	G	I	X	V	W	H	A	Z	I	E	D
K	C	V	R	A	L	E	R	G	E	A	H	D	C	N	N
N	A	M	H	A	S	U	V	S	M	R	T	V	A	B	X
A	C	L	E	I	B	R	B	L	L	K	T	O	N	I	U
L	V	S	A	W	F	I	S	H	O	C	M	I	O	C	P
P	R	S	D	I	F	U	G	E	N	X	Q	O	P	U	G
T	R	B	E	L	T	R	U	T	H	A	P	U	M	P	Z

MANTA
SANDTIGER
GRAYSHARK

GREATWHITE
WHALESHARK
HAMMERHEAD

DOLPHIN
SILVERTIP
SAWFISH

TURTLE
SEAL
PLANKTON

Activity # 4 - S.O.S Save our Sharks

Sharks can be dangerous if provoked, or in very unusual circumstances when there is lots of blood or bits of fish in the water where people are fishing. Although a few people are injured each year this is nothing compared to the injuries suffered every day in sports accidents, or on the roads.

Sharks are also becoming very rare all around the world, and one of the biggest problems is the removal of their fins for **shark fin soup**. In many places sharks are caught and their fins removed, but the rest of the body is thrown back into the sea, still alive. This is illegal in US waters, and in some parts of Europe.

Design a poster campaign to raise awareness of the importance of sharks, and to convince people, either:

a) How sharks, as top predators, play a crucial role in the oceans; or
b) Not to eat shark fin soup.

Activity # 5 - Sharks and dolphins: reputation vs. facts

Compare their reputations with facts. Dolphins are usually people's favorite sea creatures - friendly smiling playful creatures, ready to help people in jeopardy. On the contrary, sharks are seen as cruel dangerous man-eating beasts. Is this true?
To help with this comparison, and to take a comparison quiz, see the site:
http://www.dolphin-institute.org/

Answers for Activities

Unit I - Answers for Activity # 1 - True or False

1. False. Sharks have a skeleton made of cartilage.
2. True. When a shark loses or damages a tooth, it is replaced by a new one.
3. False. Sharks hear very well and can detect sound from a couple of miles away.
4. True. The largest shark in the ocean, i.e. the whale shark, has very tiny teeth and does not use its teeth to bite or chew.
5. True. Most sharks have to swim continuously in order to breathe.
6. False. Sharks live in oceans all over the world.
7. False. Sharks have lived in the ocean for over 400 million years.
8. True. Sharks can smell a drop of blood in the water from very far away.
9. False. Most sharks' eyes are located on both sides of their head.
10. True. Without their fins, sharks cannot survive.
11. False. Sharks have a sixth sense: they can detect tiny electrical impulses.
12. True. Sharks have a nose but do not breathe with it: they smell.
13. False. The dorsal fin is found on the shark's back.
14. True. Sharks are attracted to low-frequency pulsed sounds, similar to those wounded or ill prey would emit. Most attractive sounds are in the frequency of 25 to 100 Hz.
15. False. Sharks have quite exceptional eyesight.
16. True. Some sharks' eggs hatch inside the mother's body and the babies develop inside her uterus like mammals. 70% of all asharks are viviparous

Unit II - Answers for Activity # 1 - True or False

1. False. 50% of shark species never get ger than 1.80 m, i.e. 6 feet, about the size of an adult male.
2. False. Sharks do not like human flesh.
3. False. Sharks usually eat animals that are smaller than they are.
4. False. The whale shark is the largest shark and fish in the world.
5. False. The whale shark eats plankton.
6. False. If one shark kills a fish, others will come along and try to steal it. Blood in the ocean drives them crazy and they attack anything in sight thinking it is the dead prey. This is a feeding frenzy.
7. True. Some sharks are scavengers.
8. True. Humans are killing more sharks than sharks are killing men.
9. False. Most sharks have way fewer babies than fish.
10. False. Sharks are killing for food.
11. True. The largest fish in the world is the whale shark.
12. False. A manta ray does not have a torpedo-shaped body.
13. False. Sharks have no swim bladder to help keep them afloat as bony fish do.
14. False. The dorsal fin is found on the shark's back.
15. True. Sharks are very sensitive to low frequency sounds.
16. True. Bees kill more people per year than sharks do.

Unit III - Answers for Activity # 3 - Solution to Word Find

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Notes

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