



WAVE on Wheels Outreach

Shark Cart Presentation

Grades 9-12

Time requirement

1 Hour

Group size and grade

Up to 50 students maximum

Materials

2 Epaulette Sharks – in large transport cooler

1 or 2 water coolers (depending on the length of trip and need for a water change)

Mobile Shark Cart

Blue basket (including Pump, Shark Net, Electrical Cord, Paper towels)

Thermometer

Shark Artifacts Bin

Shark Emergency Water

WAVE Tablecloth

Goal

Through a live shark encounter, students will be excited, engaged, and educated about the wonders of aquatic life and the importance of conservation.

Objectives

1. Students will be able to list 5 adaptations a shark has for aquatic life including a combination of internal and external body parts as well as behaviors.
2. Students will be able to define natural selection and discuss its effects on shark adaptations.
3. Students will be able to list at least 5 species of shark and identify a unique characteristic to that species.
4. Students will be able to discuss biological factors relating to shark population numbers, individual growth rates, and reproductive success.
5. Students will be able to discuss social behavior strategies among sharks.
6. Students will be able to discuss shark conservation efforts as well as how they can help save sharks and other aquatic animals.
7. Students will be able to design and describe a method for monitoring and minimizing human impacts on shark environments.

Theme

Sharks are often misunderstood animals that play an important role in their environment.

Kentucky Core Academic Standards – Science

High School. *Interdependent Relationships in Ecosystems*

HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-LS2-8. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce

High School. *Natural Selection and Evolution*

HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

LS4.C: Adaptation

High School. *Human Sustainability*

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

ESS3.C: Human Impacts on Earth Systems

Background

Sharks are Fish

Sharks are a type of fish. They live underwater, breath water through gills, have a protective layer of scales covering their body, and are cold-blooded, or ectothermic. Worldwide there are more than 22,000 species of fish. Sharks fall into a special group of fish known as cartilaginous fish including sharks, rays, skates, and guitarfish. This group has a skeleton made of cartilage rather than bone like most fish known as bony fish. Bony fish have gas-filled swim bladders that allow vertical movement in the water column. On the other hand, sharks do not have swim bladders. They rely on lift created by their pectoral fins similar to the lift created by the wings of an airplane. Sharks also have a large oily liver, and since oil is less dense than water it creates additional buoyancy. There are several other distinct differences between sharks and bony fish. The chart below can be found at:

http://www.sharkproject.org/haiothek/index_e.php?site=evolution

	Cartilaginous fish (Chondrichthyes)	Bony fish (Osteichthyes)
Skeleton	Cartilage	Wholly or partially ossified
Gill slit cover	Open gill slits	Gill cover
Swim bladder	Not present	Present
Skin surface	Covered in dermal teeth	Covered in scales

Shark Adaptations

Sharks have several unique adaptations that help them survive in their environment. In general, sharks are darker on top and lighter below. This is a type of camouflage known as countershading. Countershading aids many aquatic animals, including sharks, as they are more difficult to see because their light undersides blend in with the sunlight. The darker upper body blends in with the ocean depths which are black as sunlight completely dissipates. Dermal denticles protect the shark and have a series of raised ridges giving sharks their sandpaper feeling. These ridges reduce drag and noise generated by a shark swimming enabling them to move efficiently in ghost-like silence. Sharks also have specialized sensory organs that detect electrical fields. These organs, called ampullae of Lorenzini, aid sharks in locating their prey by detecting tiny electrical signals from the prey's muscles. Finally, sharks have a lateral line running along each side of their body. This vibration detection area allows a shark to feel disturbances in the water column.

Shark bodies as well as shark tails, or caudal fins, come in a variety of shapes and sizes. These are adaptations to the environment of that shark species. A fusiform, or torpedo shape, is adapted for open water, while depressiform, or flattened, is adapted for living on the bottom of the ocean. A homocercal, or forked, caudal fin is built for constant swimming over long distances, while a long un-forked tail aids in maneuverability as well as living near the bottom.

Growth rates in sharks are a bit of a mystery. Many scientists are currently working on projects using radiocarbon dating and vertebral tagging to better understand the rate of growth and age of maturation of many shark species. It is well documented that growth rates in ectotherms are significantly affected by the amount of food intake. More recent studies are also showing that water temperature and carbon dioxide levels may also affect the growth rate and potential as these factors can effect metabolic rates. There is even some evidence that ocean acidification and warmer temperatures may reduce the olfactory capabilities in sharks decreasing their hunting capability.

Sharks are typical thought of as solitary animals. This is true for many species; however, some species do form groups for a variety of reasons including protection from predators, hunting behavior, and defending territories. Studies have been conducted on lemon sharks and their social groups, or shivers. When given all basic needs, lemon sharks still seek out the companionship of other similar-sized lemon sharks. Their behavior also suggests they learn from each other through vicarious learning. One group of sharks was trained to touch a target. When paired with an “untrained” partner, the untrained shark had significantly higher success rates than solitary untrained sharks. This suggests that sharks use social interactions as opportunities to learn new behaviors.

Sharks also show symbiotic relationships with other species including mutualistic relationships with cleaning species including remoras and shrimp. A few species have even been known to “play”. The Porbeagle shark is one of the few fish that seem to exhibit play behavior. There are accounts of these sharks playing with floating objects and rolling while swimming along the surface, repeatedly wrapping and unwrapping their snouts and bodies in kelp fronds, which often trail behind like rubbery streamers. Sometimes a Porbeagle with these kelp streamers was observed being chased by other Porbeagles in a possible social play ritual.

Sharks can reproduce in three distinct ways, oviparity, ovoviviparity, and viviparity. Some species practice a form of intrauterine cannibalism known as oophagy, where stronger, more developed offspring eat the remaining eggs or younger offspring to increase their chance of survival.

Shark Diets

Animal diets are closely related to the dentition, or teeth, of those animals. Sharks are no exceptions. A stereotypic shark jaw has sharp pointed teeth on top and bottom which function similar to a fork and knife tearing off pieces. Shark species with these teeth include the Great White, Bull, Hammerhead, Sand Tiger, Black Tip, and many others. Some species have small

round teeth similar to human molars designed for crushing and grinding prey with hard bodies and exoskeletons. These species typically have a mouth on the underside of their body rather than on the front of their head and include the Guitarfish (Shark Rays), Epaulette, Nurse, and Zebra Sharks. Finally, some sharks do not have teeth including Basking and Whale sharks. They obtain food by swallowing large amounts of water and filtering out organisms.

Natural Selection

Shark ancestry is a difficult field as cartilaginous fish leave very few clues. There are estimates that sharks may have been found as far back as 450 million years ago. The well-known and well-documented Megalodon, reaching lengths over 60 feet and weighing up to 100 tons, was found 2-16 million years ago and is now presumed extinct. Most modern day sharks, over the past 2 million years and through natural selection, have developed a modified circulatory system that enables them to retain metabolic heat and extend their geographic range into colder waters. Megalodon did not appear to have extended its range into cool waters suggesting it may not have developed the modern ability to retain metabolic heat. This shortcoming may have confined Megalodon into ever decreasing warmer coastal waters. Megalodon developed into the apex predator of the ocean; however, the massive size combined with a narrowing geographical range and a decreased food supply may have led to its extinction. Natural selection of adaptations takes time, and if the environmental conditions changed too fast, the species would not have been able to adapt so quickly. For a modern day example, consider the current status of the polar bear.

Shark Species

The Newport Aquarium currently displays Blacktip Reef Sharks, Nurse Sharks, Zebra Sharks, Sand Tiger Sharks, Sandbar Sharks, Scalloped Hammerhead Sharks, Epaulette Sharks, Leopard Sharks, Hound Sharks, Pajama Sharks, Cat Sharks, Horn Sharks, and a few others. The Aquarium will never display a Whale Shark, Great White Shark, or Bull Shark largely due to size restrictions as well as the behavior of those species. The Whale Shark is the largest fish in the ocean reaching lengths of more than 40 feet and weighing more than 20 tons. The smallest shark is currently thought to be the Dwarf Lanternshark or the Ninja Shark reach lengths of 6-8 inches maximum. The species implicated in the most shark attacks include the Great White Shark, Tiger Shark, and Bull Shark. The species displayed for the outreach program is an Epaulette Shark. These unique sharks are bottom dwellers with crushing dentition. They exhibit several adaptations for life in a tide pool habitat.

Food Web Connections

As with most apex predators, sharks play a critical role in their ecosystem as a top down control mechanism for the environment's food web. Apex predators consume tertiary and/or secondary consumers, which consume primary consumers, which consume producers, which produce energy from the sun through photosynthesis. The main source of energy for all ecosystems initiates from the sun in the form of solar energy. Through the process of

photosynthesis, plants convert this energy into oxygen and glucose. Because of this conversion, green plants, some bacteria, and algae are labeled as producers. An animal, such as an herbivorous fish, who consumes the plant, is known as a primary consumer, because it receives the energy from the plant which converted the energy from the sun. The shark who eats the fish that feeds on the plant which converted the sunlight is known as a secondary consumer, hence a process that directly relates back to the sun as the primary energy source. An apex consumer is the top of the food chain or food web with few to no natural predators at adult size.

Shark Conservation

As the demand for shark products increase, so does the concern for shark populations and the sustainability of global fisheries. Sharks are characterized by slow growth rates, late maturity, and fewer offspring. These factors leave many species of animals, including sharks, vulnerable to overfishing. Sharks may be caught as bycatch in other fisheries or directly targeted for markets such as the shark fin soup industry. Increased pressure from other fisheries can also have an indirectly negative effect on shark species. As more prey items are harvested from the oceans, fewer food resources are left for large predators. A limiting resource is an environmental condition that limits the growth, abundance, or distribution of an organism or a population of organisms in an ecosystem. Consider the fact that an adult Great White Shark consumes on average 11 tons of food per year. An average human may reach half a ton annually.

The WAVE Foundation's Aquatic Conservation Fund supports a variety of organizations whose chief mission is to protect natural resources and environments. Misión Tiburón's goal is to promote the conservation and responsible use of marine resources, especially of sharks, through the development of integrated projects of marine education and scientific research. Their current project is titled "Conservation of Scalloped Hammerhead Shark (*Sphyrna lewini*) and its critical habitats in the Eastern Tropical Pacific." As part of this program, researchers conducted educational activities in adjacent coastal communities to the breeding areas of the hammerhead shark. They also presented participatory workshops were held with respective fisheries cooperatives and associations, to develop effective management actions to decrease the fishing mortality of the offspring hammerhead shark. By involving the community, the goal is to increase survival of juveniles and consequently improving future adult population reproduction.

The Fund is also supporting the University of Hawaii's Hawaii Institute of Marine Biology with Scalloped Hammerhead tracking using various satellite tags. The aim of this study is to sample throughout the north, mid, and southern portions of the bay over at least two pupping seasons (2 years). They hope to address questions such as how many pups are in the bay and what is the variation like between years. By tagging sharks with individual numbers they will also be looking at their distribution and large-scale movement patterns within the bay. In addition,

they will be looking at field growth rates and at time-at-liberty (to estimate residency time). Furthermore, they are collecting fin clip samples of the pups for genetic analysis.

Finally, WAVE is assisting the O'Seas Conservation Foundation in Shark Science and Youth Education. By integrating shark tagging with youth education, this innovative approach will enhance our knowledge pertaining to an understudied species and will help to secure our future through the education and motivation of our environmentally conscious youth. In collaboration with Shark Diving Unlimited and Stellenbosch University, the aims of the Sharksafe Barrier Project were to develop and deploy a new technology that could be used to non-invasively separate predatory sharks from beachgoers to alleviate the need for beach nets. This research started in November 2010 and successfully demonstrated that the swim patterns of white sharks (*Carcharodon carcharias*) can be manipulated in the presence of the newly developed Sharksafe Barrier.

Vocabulary

Conservation – the study of the loss of Earth's biological diversity and ways this loss can be prevented

Depressiform – flattened or dorso-laterally compressed

Fusiform – torpedo shaped, tapering at both ends

Homocercal – forked, appearing outwardly symmetrical but with the backbone passing into the upper lobe

Limiting factor - a factor present in an environment that controls a process, particularly the growth, abundance or distribution of a population of organisms in an ecosystem

Mutualism - two organisms of different species exist in a relationship in which each individual benefits from the activity of the other.

Natural selection - process by which organisms that are better adapted to their environment tend to survive longer and reproduce more succeeding generations than those individuals that are less well adapted.

Ocean acidification - a reduction in the pH of the ocean over an extended period time, caused primarily by uptake of carbon dioxide from the atmosphere.

Oviparity - producing eggs that mature and hatch after being expelled from the body

Ovoviviparity - producing eggs that are hatched within the body, so that the young are born alive but without placental attachment

Photosynthesis - process by which green plants and some other organisms use sunlight to synthesize foods from carbon dioxide and water

Play behavior - activities performed for self-amusement that have behavioral, social, and psychomotor rewards

Radiocarbon dating - a technique for determining the age of organic materials, based on their content of the radioisotope carbon 14 acquired from the atmosphere

Shiver – a group of sharks

Symbiotic - organisms that live together; however, the relationship is not necessarily beneficial to both. (ie parasite-host)

Vicarious learning - a change in behavior due to the experience of observing a model
Viviparity - development of the embryo inside the body of the mother, eventually leading to live birth

Extension Activities

Project WILD Activities. Please contact your state Project WILD coordinator for more information. See <http://projectwild.org/KentuckyCoordinator.htm> (for Kentucky) or <http://www.projectwild.org/ProjectWILDCoordinators.htm> (for other states).

- Back from the Brink – Students will (1) explain the reasons for the decline of certain wildlife species and describe methods used in species recovery, (2) describe the effects of the decline and recovery of wildlife on people and the environment, (3) analyze issues surrounding the decline and recovery of wildlife species and examine strategies to resolve those issues, and (4) describe the importance of an environmentally literate citizen base to the success of the recovery project.
- Bird Song Survey – Students will identify and describe the importance of bird counting as one means of inventorying wildlife populations.
- Can Do! – Students will (1) identify a problem involving wildlife in their community, (2) suggest and evaluate alternative means by which to either solve the problem or at least improve the situation, (3) successfully undertake the project, and (4) analyze and describe the process by which they successfully solved the problem or improved the situation.
- Know the Legislation: What’s in It for Wildlife? – Students will (1) describe the legislative process in which a bill becomes law, (2) identify points when private citizens can have an effect on the legislative process, and (3) evaluate the effectiveness of the legislative process from the perspective of the students’ personal experience.
- Turkey Trouble – Students will (1) define and give examples of exponential and linear growth rates in wildlife populations, and (2) describe factors that affect and limit growth of wildlife populations.
- We’re in This Together – Students will (1) identify environmental problems of concern to both people and wildlife, and (2) generalize that people, domesticated animals, and wildlife are subject to similar environmental problems.
- Wildlife Issues: Community Attitude Survey – Student will (1) assess the values held by various groups and individuals regarding a selected issue, and (2) distinguish between beliefs, values, and attitudes.
- Wildlife Research – Students will (1) identify reasons for research related to wildlife, (2) evaluate appropriate kinds of research related to wildlife, and (3) design and conduct a wildlife research project.

Make Your Own Sharkometre! -

https://www.sharktrust.org/shared/downloads/educational_resources/sharkometer.pdf

How a Shark Jaw Works! -

<http://sharkopedia.discovery.com/shark-topics/feeding-hunting-diet/#how-a-sharks-jaws-work>

Resources

WAVE Foundation - <http://www.wavefoundation.org>

Project Wild - <http://www.projectwild.org>

Project Wet - <http://www.projectwet.org>

Project Learning Tree - <http://www.plt.org>

Endangered Species Information -

<http://education.nationalgeographic.org/media/endangered/>

Shark Information - <http://www.discovery.com/tv-shows/shark-week/>

Shark Information - <http://sharkopedia.discovery.com/>

Shark Information - <https://www.flmnh.ufl.edu/fish/discover/species-profiles/hemiscyllium-ocellatum/>

Conservation Efforts - <http://wavefoundation.org/conservation/conservation-fund/>