WAVE on Wheels Outreach

Shark Cart Presentation

Grades 6-8

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 list at least 5 species of shark and identify a unique characteristic to that species.
3. Students will be able to discuss biological factors relating to shark population numbers, individual growth rates, and reproductive success.
4. Students will be able to describe that all energy in a food web originated from the sun.
5. Students will be able to discuss shark conservation efforts as well as how they can help save sharks and other aquatic animals.
6. 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

Sixth Grade - *MS. Matter and Energy in Organisms and Ecosystems*

06-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organism and populations of organisms in an ecosystem.

LS2.A: Interdependent Relationships in Ecosystems

Seventh Grade - *MS. Growth, Development, and Reproduction of Organisms*

07-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

07-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

Eighth Grade - *MS. Interdependent Relationships in Ecosystems*

08-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.*

Eighth Grade - *MS. Human Impacts*

08-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*

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 being 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. 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.

Shark Species

The Newport Aquarium currently displays Black Tip 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, an 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.
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.
Symbiotic - organisms that live together; however, the relationship is not necessarily beneficial to both. (ie parasite-host)
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).

- Bearly Growing – Students will compare similarities and difference between the growth of black bears and humans.
- Bottleneck Genes – Students will (1) describe biodiversity as it relates to natural systems, species, or individuals; (2) articulate that genetic diversity is essential to the health of a species because it facilitates adaptation to change and provides sources for new genetic material; (3) explain how natural selection favors individuals with traits adapted to their environment; and (4) explain that for a wildlife population to sustain itself, there must be enough habitat to support a healthy-sized population that will carry a healthy-sized gene diversity.
- Career Critters – The students will (1) identify five examples of how wild animals and plants can be used to manage some environmental problems, and (2) describe and give examples of an organism and its niche.
- Carrying Capacity – Students will (1) formulate and test hypotheses related to wildlife populations and carrying capacity, and (2) describe the significance of carrying capacity.
- Changing Attitudes – Students will (1) give an example of a chance in attitudes related to a wild animal or the environment, and (2) describe factors that may influence changes in attitudes.

- Ecosystem Facelift – Students will (1) describe interactions or interdependency of organisms within an ecosystem; (2) articulate that managing an ecosystem as a whole, and not just for one or a few species, is essential for ensuring ecosystem diversity; and (3) relate the increase of wildlife populations to the improvement of habitats.
- Ethi-Reasoning – Students will (1) examine their own values and beliefs related to wildlife and other elements of the environment, (2) listen to and respect the right of other to maintain different values and beliefs, and (3) evaluate possible actions they might take that have an effect on wildlife and the environment.
- Litter We Know – Student will (1) identify and evaluate ways that litter pollution can endanger wildlife, and (2) propose ways to help eliminate these dangers to humans and wildlife.
- Oh Deer! – Students will (1) identify and describe food, water, and shelter as three essential components of habitat; (2) describe factors that influence carrying capacity; (3) define "limiting factors" and give examples; and (4) recognize that some fluctuations in wildlife populations are natural as ecological systems undergo constant change.

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/