

The Truth About Sharks

Video Narrations

Chapter 1: Shark and Humans: A Complicated Relationship

Sharks have inhabited the ocean for hundreds of millions of years. Much older than the dinosaurs, sharks have survived several mass extinction events. They are true survivors. Over millions of years, they have radiated into nearly every aquatic habitat on Earth, giving rise to over 500 species that possess unique adaptations. As humans, our relationship with sharks has developed into a complicated one. Most people fear sharks. Where does this fear come from? When Hollywood released the movie *JAWS* in 1975, it struck a nerve. The aftermath was generations of people who feared and even hated sharks. Sharks were killed in great numbers for sport, for fun, and for revenge. Well into the 1980's and 90's, sharks were in real trouble. Sharks were being fished from the ocean at unsustainable rates as the efficiency of our global fishing efforts increased. The result was that many shark species began to dramatically decline. One of the primary reasons sharks are overfished is for their fins to support the demand for shark fin soup, an Asian cultural delicacy. Do we need a way to triumph over our fear of them? We have learned the consequences and lessons of removing predators from environments before such as mastodons, wolves, bison, and whales. We know predators play a vital role in ecosystem health. Today, people are fighting for the rights of sharks, giving them the voice they don't have. We know that sharks are worth far more alive than dead. They sustain healthy ecosystems and bring in economic value through tourism. People pay millions of dollars annually to swim and dive with sharks, positively impacting many coastal communities. Shark sanctuaries dot the globe, affording sharks protection from fishing and exploitation. But will it be enough?

Chapter 2: Evolutionary History and Major Groups

When we think of ancient animals, we often think back to the age of the dinosaurs. But even before they roamed the land, there were sharks in the oceans. Sharks were one of the first jawed vertebrates dating back more than 440 million years ago. Our understanding of the earliest sharks comes from the fossil record. Sharks do not fossilize particularly well because their skeletons are comprised of cartilage, which typically disintegrates before fossilization can occur. Full body fossils of sharks are rare and reconstructions are commonly based off of teeth, fins, spines, and scales. Early sharks were different from the ones we see today, many with rather unusual characteristics. One prehistoric shark within the family *Stethacanthidae* had a dorsal fin that resembled a large flat spiny plate and a circular patch of spines on top of the head. The function is unknown. Another fascinating prehistoric species, *Heliocoprion*, existed 290 million years ago and had an extensive tooth whorl, like a circular saw, in its lower jaw. Today there are over 509 extant shark species. When we study sharks, we are really looking back in time at all of the habitats and adaptations that gave rise to the rich species diversity we see today.

Chapter 3: Sharks Are Fish

Sharks are cartilaginous fish that are closely related to skates and rays. They are known collectively as elasmobranchs. Sharks have skeletons composed of cartilage, which includes the vertebral column, cranium, jaws, and connections to rigid fins. A caudal fin allows a shark to propel through the water, while they use their dorsal fin and pectoral fins for steering and maneuvering. Thousands of placoid scales, called dermal denticles, make up shark skin. These scales are sharp, shaped like tiny teeth, and function to protect the shark and break up surface tension as the shark swims. The teeth inside shark jaws are modified scales and are continually replaced as if they were on a conveyor belt. Replacement dentition is an adaptation that ensures sharks always have sharp and functional teeth. Just like us, sharks require oxygen to survive and extract it from the water using their gills. Some species are ram ventilators that must continually swim, forcing oxygenated water to flow over the gills. Other species are buccal pharyngeal pumpers that have the ability to actively pump water over their gills, allowing them to have a more sedentary lifestyle on the seafloor and among crevices in the reef.

Chapter 4: Reproductive Biology

Like humans, sharks invest considerable energy into producing few, relatively large young. The age of maturity varies widely among species, but most mature from 6 to 16 years. Fertilization occurs internally. There are three main development modes and embryonic nutrition that characterize families and orders of sharks. About 40% of all sharks have maintained the most primitive developmental condition, which is egg laying, or oviparity. This is where the embryo receives nutrients from yolk within the egg case. However, most sharks give birth to live young. There are several unique developmental distinctions among this group. In nearly half of live bearing sharks, the embryo is retained and nourished inside the female uterus with a yolk-sac attached directly to the digestive system. This is termed yolk-sac viviparity or aplacental viviparity. In an extreme case, Whale sharks have been found with over 300 embryos inside their body, all in different stages of development, making them the most fertile of all sharks known. The most advanced mode of reproduction is placental viviparity and is seen in modern shark families and hammerhead sharks. The embryo initially has a yolk-sac, but midway through gestation, the yolk sac is exhausted and attaches to the uterine wall forming a yolk-sac placenta similar to mammals.

Chapter 5: Sensory Biology

Sharks are legendary for their keen senses. Over millennia, their sensory systems have streamlined to provide near instantaneous information about their environment. A shark's central nervous system detects chemical, mechanical, visual, and electrical signals which result in an array of physiological and behavioral responses. Sharks use different senses from different distances to detect prey. Up close, sharks can see and detect movement. Sound and odor travel from longer distances. Sharks evolved the ability to detect weak electric fields generated by every living thing in the water at very close distances. The electrosensory system is unique in elasmobranchs and functions through jelly filled canals, the Ampullae of Lorenzini, located in the snout and head of sharks. Scientists have generated weak electric fields in the lab

to determine just how sensitive and far away sharks can detect the signal. In experiments, scientists present sharks with an odor to get them into classic hunting mode. Then, the electric field is turned on and scientists record the behavioral responses and detection distances to the electric field. The sharks bite at what they think is prey! These data are being used in new ways to aid fisheries in keeping unwanted sharks off fishing lines. It is an emerging strategy that exploits the secret electric communication channel sharks use by using a large field which repels certain shark species.

Chapter 6: Food Webs

Many shark species are apex predators. They directly and indirectly control the populations of many other species, maintaining the delicate balance of the entire ecosystem. When sharks are removed from an ecosystem, it can have unexpected and cascading effects on a multitude of species. For example, removing sharks from a coral reef can indirectly harm the reef. As sharks are no longer preying upon mid-sized carnivorous fish, the herbivorous fish are in turn over consumed. The loss of herbivores allows for algae to overgrow entire reefs, causing reef health to decline. Humans have not always understood the vital role of predators, and repeatedly over time, we have seen the dire consequences of their loss in entire ecosystems. Through the efforts of many scientists and fisheries managers, now ecosystem management principles are being pushed to the forefront. This has led to designating large areas of the ocean as sanctuaries and protected areas for sharks. The ecological benefit and critical role sharks play has encouraged healthy, abundant, and alive sharks.

Chapter 7: The Bizarre and Fascinating

When we study sharks, we are looking back in time at the events and environmental conditions that have shaped species and their unique adaptations. Today, over 500 shark species represent a lineage that has endured across time. They have survived five mass extinction events and have radiated extensively since then. There are many species that are truly bizarre and have fascinating and unique characteristics. Welcome to a short journey to see and understand the weird, wild, and bizarre!

From glow in the dark to cookie cutter sharks, pocket to pajama sharks, and all the way to angel sharks, there really is a rainbow of diversity. Of the many sharks in the ocean, there is one that might even take your breath away or haunt you. Its the Goblin shark. With a strange looking head and a long extended snout that is believed to aid in finding prey, the goblin shark also has jaws that can protrude out to help in the capture of deep sea prey. Hammerheads are also truly unique. There are over 9 hammerhead species that all have a gradation of head expansion, from modest in the bonnethead to boomerang shaped in the winghead shark. They are the most recently evolved sharks in the ocean and scientists are not sure why the hammer appeared in the first place.