Sea Stats

Florida Fish and Wildlife Conservation Commission

Fish and Wildlife Research Institute

HORSESHOE CRABS

Living Fossils

The horseshoe crab is one of Florida's most mysterious and fascinating creatures. Although extensive research has been conducted, much is still unknown about this animal. Horseshoe crabs belong to a class of animals called Merostomata, a group more closely related to spiders and scorpions (Class Arachnida) than to true crabs (Class Malacostraca). Unlike true crabs, horseshoe crabs do not possess antennae, and they have seven pairs of appendages, whereas true crabs have only five pairs. The fossil record suggests that the ancestors of horseshoe crabs were common about 445 million years ago, long before the age of the dinosaurs. Physically, horseshoe crabs have changed very little since that time. Amazingly, these animals have survived several mass extinctions in which many other of the world's plants and animals died off, making it no surprise that horseshoe crabs are often called "living fossils."

Distribution and Habitat

Only four species of horseshoe crabs exist today, three of which are found in the western Pacific Ocean, from Japan to Vietnam. The fourth species, *Limulus polyphemus*, is found in North America along the Atlantic and Gulf coasts from Maine to Florida, and in the Yucatan Peninsula in Mexico.

North American horseshoe crabs are most abundant in temperate waters, especially off the coast of the mid-Atlantic states, including Delaware, Maryland, and New Jersey. In Florida, horseshoe crabs are a conspicuous part of the marine ecosystems throughout the state. Visitors to Florida's beaches have more than likely seen these creatures emerging from the water to mate and lay eggs. Horseshoe crabs nest on sandy beaches with low wave action, mainly during full and new moons at high tide. When not spawning, horseshoe crabs live on the continental shelf in water up to about 60 feet deep.

Description and Anatomy

One of the most notable features of the horseshoe crab is its prehistoric body shape and sharp tail, which unfortunately gives this animal an unfavorable reputation. In fact, the horseshoe crab was most likely given its scientific name, *Limulus polyphemus*, because of its odd appearance—*Limulus* means a little "askew" or "odd" in Latin, and *polyphemus* is the name of the giant cyclops of Greek mythology. Despite its fearsome look and name, the horseshoe crab is harmless.

The body of the horseshoe crab is divided into three regions: the cephalothorax, the abdomen, and the telson.

At a glance

Scientific name	*Limulus polyphemus*
Size	Up to two feet in width. Males are about one-third the size of females.
Range	Atlantic Ocean and Gulf of Mexico, from Maine to Florida, and on the Yucatan Peninsula
Habitat	Juveniles live on sandy intertidal flats and move farther offshore when they become adults.
Status	Population trends are poorly understood in Florida.

The cephalothorax, covered by the carapace, or shell, is the large anterior segment of the horseshoe crab. The carapace protects the legs and organs of the horseshoe crab and keeps the animal upright in rough waters. Located on top of the carapace are two lateral compound eyes that are used to detect movement and locate mates. Each compound eye contains thousands of photoreceptor clusters called ommatidia. Horseshoe crabs also have eight other photoreceptor-containing structures located on various parts of their bodies, bringing their total number of eyes to 10. Signals from photoreceptor cells to the brain influence the horseshoe crab's circadian rhythm (inner clock) and various daily physiological processes.

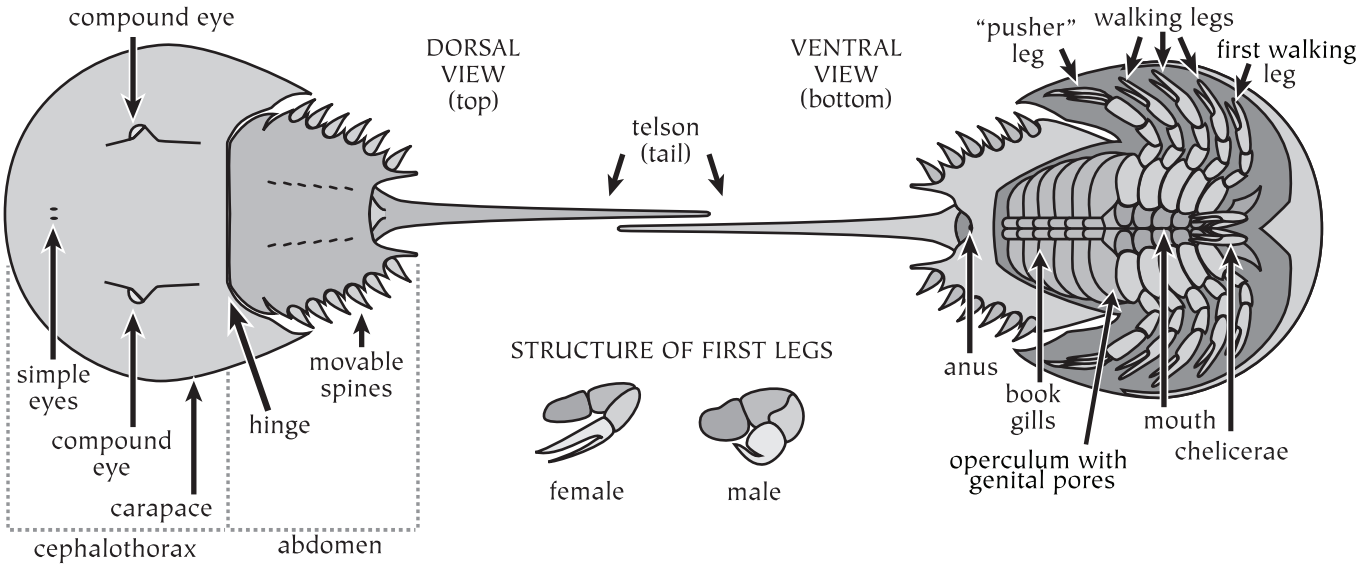
The underside of the horseshoe crab consists mostly of paired appendages. The anterior-most appendages are called the chelicerae and are used for feeding. Food is picked up by the chelicerae and passed to the mouth, located between the bases of the legs. Food is then passed through the digestive system and expelled through the anus, located on the underside just in front of the tail. The middle four pairs of appendages are walking legs and have small claws at the ends. In males, the first pair of walking legs have modified hook-like structures that are used to attach to females during mating. The last pair of appendages (pusher legs), in both sexes, are brush-like and are used for movement on land and for digging.

The abdomen is the middle body region of the horseshoe crab and is attached to the cephalothorax by a simple hinge joint. The underside of the abdomen consists mainly of respiratory and reproductive structures, the most visible of which are the six book gills. The first pair of gills are the operculum which bears the openings of the genital pores where eggs and sperm are released during mating. The operculum covers the five other pairs of gills, which are used for respiration. The horseshoe crab continuously moves the book gills to keep oxygenated water flowing around them.

The third body region of the horseshoe crab is the telson or tail. The telson is connected to the abdomen by a ball and socket joint, which allows the tail to move in multiple directions. Contrary to popular belief, the spike-like tail is not used as a weapon. Horseshoe crabs often use their tails to right themselves when accidentally overturned. There is no evidence that the tail is ever used for defense against humans, or the horseshoe crabs' few natural predators, such as loggerhead sea turtles and tiger sharks.

Reproduction and Life History

In Florida, horseshoe crabs may mate year-round, although spring is the peak season, with a lesser peak occurring in the fall. Horseshoe crabs aggregate on low-energy beaches to mate, nest, and spawn, usually at high tide during the three days before and after a new or full moon. It is common to see paired horseshoe crabs moving onto the beach during these times; with a smaller male attached to the back of a larger female (male horseshoe crabs are about one-third the size of females). Males mate two different ways. One method is for the male to attach to a female using his hook-like front appendages. Together, they will crawl onto the beach, where spawning takes place. Often, many single or "satellite" males will crowd around the attached pair. Both the attached and



satellite males fertilize the eggs externally as the female lays them in a nest in the sand. During spawning, a female horseshoe crab lays an average of 60,000 eggs in several "clutches" of roughly 2,000 eggs per clutch. Horseshoe crab sperm remains viable in saltwater for up to 96 hours. Thus, several different males may father eggs from a single egg clutch. To ensure reproductive success on additional visits to beaches, males will often remain attached to a female for several weeks at a time.

Horseshoe crab eggs are green and only about 1/16 inch in diameter when they are laid. Over a period of two to five weeks, the embryos develop into larvae, relying on nutrients from their yolk sacs while their digestive system develops. After emerging from the yolk sac the larvae are capable of swimming and feeding. Shortly after they will molt into juveniles that resemble adults with proportionally smaller tails. Young horseshoe crabs are good swimmers but spend most of their time on sandy intertidal flats within a few yards of the beach. Larger juveniles are found lower in the intertidal zone, and subadults are at the seaward limit of the intertidal zone. Adult horseshoe crabs live offshore, except when spawning.

Horseshoe crabs use their chelicerae (the first pair of appendages or legs) to feel around the sandy bottom for prey such as mollusks, polychaete worms, and dead fish. Like other arthropods, horseshoe crabs grow by periodically molting (shedding) their exoskeletons. At each successive molt, horseshoe crabs grow 20–30 percent by absorbing water to expand their new shells, which harden within 24 hours. Male horseshoe crabs reach sexual maturity after about 16 molts which takes approximately 9 years. Females need to molt at least one additional time and reach maturity between 10 and 12 years. After maturity, horseshoe crabs stop molting and may live another 6 to 10 years.

In general, horseshoe crabs do not travel long distances. Tagging studies of horseshoe crabs indicate that males return to spawning beaches more frequently than females, and most horseshoe crabs do not move far away from these beaches during the breeding season. In one study in Apalachee Bay, Florida, the average distance traveled for 40 tagged horseshoe crabs was 4.1 nautical miles. However, one individual traveled 22 miles and another animal tagged in Cedar Key moved 45 miles.

Importance of Horseshoe Crabs

Horseshoe crabs are an important ecological component of coastal communities. Like most organisms that produce thousands of eggs in a relatively short season, few of their eggs and offspring survive to maturity. Horseshoe crab eggs are an important food source for many animals, including many species of fish and birds. Migrating shorebirds rely heavily upon the eggs during the nesting season, especially the increasingly rare Red Knot. Without an abundant supply of horseshoe crab eggs, these migrating birds would not acquire the energy reserves needed to fly their long migration routes to the Arctic. In the mid-Atlantic states, more than 50 percent of the diet of many shorebird species consists of horseshoe crab eggs. In Florida, Red Knots, Ruddy Turnstones, Sanderlings, Dunlins and Short-billed Dowitchers have been seen foraging on horseshoe crab eggs.

Marine invertebrate species, such as barnacles, mussels, sponges and flatworms, attach to the carapace of horseshoe crabs. These organisms are left on the exoskeleton when the horseshoe crab molts, leaving the horseshoe crab clean of external organisms until more settle and attach themselves to the shell. Upon reaching adulthood, the horseshoe crab undergoes a final "terminal" molt, and no longer sheds its shell nor any organisms attached to the crab. Old crabs can be literally covered with these "epibionts" and enable scientists to estimate the age of the crab.

Humans harvest horseshoe crabs for many different uses. Horseshoe crabs were once widely used as fertilizer for crops, which caused a decline in population sizes. The horseshoe crab fertilizer industry decreased through the 1950s and stopped altogether by 1970. Horseshoe crabs have also been used as feed for chickens, hogs and other livestock. Currently, horseshoe crabs are used as bait in the American eel and whelk fisheries along many parts of the Atlantic coast. Eel fishermen use mostly egg-bearing female horseshoe crabs, whereas whelk fishermen use both males and females. Florida has a small eel fishery, mainly on the east coast of the state, and limits the harvest of horseshoe crabs to 9,455 animals annually.

When harvesting horseshoe crabs for bait began in the mid-1970s, landings averaged about 50,000 pounds per year. By the mid-1990s, landings averaged over 670,000 pounds per year. At this time, conch fishing suddenly increased dramatically and horseshoe crab landings peaked at 6 million pounds in 1997. In 1998, a federal management plan was developed, and thereafter landings decreased each year to about one million crabs collected annually since 2001.

In Florida, live horseshoe crabs are also collected by the marine life industry for resale as aquarium organisms. Since 1998, an average of 25,000 juvenile horseshoe crabs per year are taken for this purpose.

Horseshoe crabs are also important to biomedical research. The horseshoe crab is the most studied invertebrate

in the world, and several Nobel Prizes have been awarded to researchers based on their work on horseshoe crabs. During the past 50 years, research on the compound eyes of horseshoe crabs has led to a better understanding of how human eyes function. Researchers have also discovered that chitin, which makes up the horseshoe crab's shell, can shorten the healing time of wounds by 35–50 percent and reduces pain compared to other standard treatment. As a result, chitin is now used to make dressings and sutures for burns, surface wounds, and skin-graft donor sites.

In the 1950s, scientists discovered that horseshoe crab blood clots in the presence of small amounts of bacterial toxins. The compound in their blood responsible for this clotting is called Limulus Amoebocyte Lysate (LAL). Since the mid-1980s LAL has become the standard test to ensure that anything that enters the human body, (example: injectable drugs and vaccines, artificial hip replacements, heart valves, surgical equipment, to name a few) is bacteria-free. As a result, LAL is in high demand worldwide.

Fortunately, the bleeding process is not generally harmful to the horseshoe crabs. Pharmaceutical companies remove about one-third of the animal's blood, and the horseshoe crabs are released back into the water. Based on scientific studies, mortality to horseshoe crabs is roughly 15 percent due to biomedical bleeding.

Management and Research Efforts

Some recent studies suggest that horseshoe crab abundance may once again be declining in some areas, especially in New England. Although scientists are unsure of the exact causes of this decline, it is likely due to a variety of factors, including habitat degradation and overfishing. Reproductive activities of horseshoe crabs can be disrupted when seawalls or other types of development block the shoreline. Harvesting horseshoe crabs during the reproductive season can reduce the ability of the population to replenish itself.

Florida implemented rules for managing the harvest of horseshoe crabs in 2000. Individuals with a valid saltwater products license can harvest up to 25 horseshoe crabs by hand or gig, per day. Individuals with a valid saltwater products license, a restricted species endorsement, and a marine-life endorsement, or a permit to harvest freshwater eels commercially can harvest up to 100 horseshoe crabs per day. Though biomedical harvest is legal in Florida, special use permits and/or additional biomedical permits are required.*

In 1998, the Atlantic States Marine Fisheries Commission developed a Horseshoe Crab Fishery Management Plan. One requirement of the fishery management plan is that all Atlantic coastal states identify horseshoe crab spawning habitat. The overall goal of this plan is to conserve and protect the horseshoe crab while maintaining its use in the various industries described above. Many Atlantic states are now facilitating volunteer programs where the public can become involved in collecting valuable data on location and timing of spawning activities, to help monitor the status of various populations during the nesting season.

Biologists at the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute initiated a horseshoe crab survey in 2002. The goal of this survey is to locate nesting beaches around the state with the help of the public. Anyone who observes mating and nesting activities can document the critical locations where nesting occurs. If you observe any reproductive activities of horseshoe crabs, please report the information on (1) the location of your observation, (2) date and time of your observation, (3) an estimate of the number of horseshoe crabs seen, and (4) whether the horseshoe crabs were mating (i.e., two or more horseshoe crabs attached). Information can be reported by toll-free phone (866-252-9326), by e-mail (horseshoe@MyFWC.com), or through an on-line survey (http://www.surveymonkey.com/s/horseshoe_crab). Additionally, more scientifically-based surveys conducted by citizen scientists are being developed for implementation around the state over the next several years, with the hope that managers will be able to better assess Florida's horseshoe crab population.

*Fishing regulations may change annually. Contact the FWC Division of Law Enforcement for information about current regulations. You can also view the current saltwater fishing regulations online at MyFWC.com/marine.

Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute
100 8th Avenue SE, St. Petersburg, FL 33701 • (727) 896-8626 • MyFWC.com/Research