Atlantic Horseshoe Crab
Limulus polyphemus

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DESCRITPION

Taxonomy and Basic Description

Despite their name, horseshoe crabs are not true crabs. The Atlantic horseshoe crab, *Limulus polyphemus*, is the only member of the Arthropoda subclass Xiphosura found in the Atlantic. Unlike true crabs, which have 2 pairs of antennae, a pair of jaws and 5pairs of legs, horseshoe crabs lack antennae and jaws and have 7 pairs of legs, including a pair of chelicerae. Chelicerae are appendages similar to those used by spiders and scorpions for grasping and crushing. In addition, horseshoe crabs have book lungs, similar to spiders and different from crabs, which have gills. Thus, horseshoe crabs are more closely related to spiders and scorpions than they are to other crabs. Their carapace is divided into three sections: the anterior portion is the prosoma; the middle section is the opithosoma; and the "tail" is called the telson. Horseshoe crabs have two pairs of eyes located on the prosoma, one anterior set of simple eyes, and one set of lateral compound eyes similar to those of insects. In addition, they possess a series of photoreceptors on the opithosoma and telson (Shuster 1982).

Horseshoe crabs are long-lived animals. After attaining sexual maturity at 9 to 12 years of age, they may live for another 10 years or more. Like other arthropods, horseshoe crabs must molt in order to grow. As the horseshoe crab ages, more and more time passes between molts, with 16 to 19 molts occurring before a crab becomes mature, stops growing, and switches energy expenditure to reproduction. Adult horseshoe crabs feed on a variety of bottom-dwelling organisms including marine worms, shellfish, and decaying animal matter. The larvae and juvenile stages are preyed upon by many species of fish and birds, while adult horseshoe crabs are known to be an important food item for the threatened loggerhead sea turtle, *Caretta caretta* (Keinath et al. 1987). Horseshoe crab eggs are also the primary source of fat for at least 20 species of migratory shore birds (Harrington 2001). There is great concern about the harvest of horseshoe crabs in the mid-Atlantic and how it affects the red knot, *Calidris canutus*, an imperiled species of bird (Piersma and Barker 2000).

Horseshoe crabs are also harvested for use in biomedicine. A clotting agent in horseshoe crab blood (or haemolymph), known as *Limulus* Amoebocyte Lysate (LAL), is used to detect microbial pathogens in medical intravenous fluids, injectable drugs, and supplies (Rudloe 1983). Biomedical companies purchase large horseshoe crabs which are harvested by trawlers or by hand from spawning beaches. The crabs are transported to the LAL production facility, bled, and then transported back to the general harvest vicinity and released alive. LAL is currently used worldwide as the standard (FDA required) test for microbial contamination in injectable pharmaceutical products (Walls and Berkson 2000). Horseshoe crabs have also been used in eye

research and the development of wound dressings and surgical sutures. In addition, horseshoe crabs are currently the primary bait used in the whelk and eel fisheries along the Atlantic coast (ASMFC 1998). [Note: The horseshoe crab is also discussed in the Intertidal Marine Invertebrates Guild.]

Status

This species is not currently listed as threatened or endangered; however, horseshoe crabs are an important species, both commercially and ecologically. Ecologically, horseshoe crabs are an important component of coastal food webs. Horseshoe crabs have been shown to be a controlling factor in benthic species composition through their feeding activities.

POPULATION SIZE AND DISTRIBUTION

Horseshoe crabs are relatively common in trawls in South Carolina. Research trawl collections can be used to obtain an approximate measure of relative abundance, although there is no current estimate of population size.

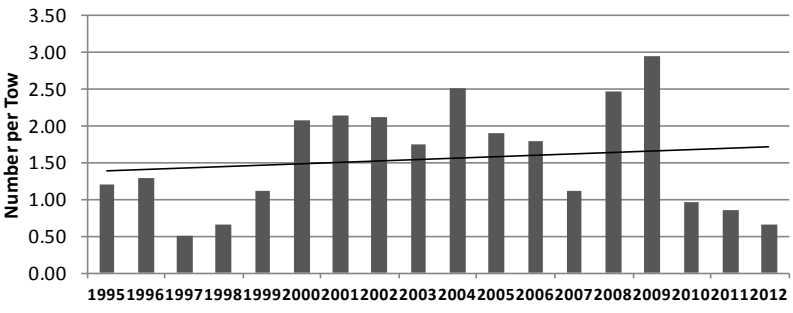

Figure 1. SCDNR Crustacean Monitoring Section horseshoe crab catch rate from trawl survey. Sampling changes beginning in 2002 required standardized rates.

The range of the horseshoe crab extends from northern Maine to the Yucatan Peninsula. Horseshoe crabs are particularly abundant in Delaware Bay, the center of their distribution, and in coastal areas between Virginia and New Jersey. Different populations of horseshoe crabs are thought to inhabit every major estuary along the Atlantic Coast. Each population can be differentiated from the others based on size of the adult crabs, the color of their carapace, and the pigments present in their eyes. In South Carolina, horseshoe crabs can be found in shallow estuarine areas and offshore habitats near the continental shelf.

HABITAT AND NATURAL COMMUNITY REQUIREMENTS

Adult horseshoe crabs are benthic animals. Early each spring, as estuarine water temperature approaches 20°C (68°F), adult horseshoe crabs move inshore to seek suitable spawning habitat along intertidal beaches of the sea-islands. The characteristics associated with preferential spawning locations are the presence of large intertidal sand flats near the spawning beach, a depth to reducing layer greater than 30 cm (12 in.) from the surface, and accretional rather than erosional sediments (Thompson 1999).

Throughout the spring, females with males attached to their carapace follow flooding tides high onto the beaches where they excavate nests and deposit thousands of eggs. During mating, the male grasps the carapace of the female and fertilizes her eggs as she deposits them in the nest cavity. Oftentimes, other unattached "satellite" males may also fertilize some of these eggs. Mating and nesting activities both coincide with high tides. Nests are excavated by the female on the intertidal zone of sandy beaches, and eggs are laid in clusters. Spawning activity is especially high during night-time spring tides. Females nest several times per season, usually returning to deposit more eggs on subsequent high tides. After approximately 2 weeks, depending on temperature, moisture, and oxygen levels, larval horseshoe crabs emerge from the nest. Larval horseshoe crabs are semi-planktonic for about 3 weeks before their transition to a benthic existence. They then settle to the bottom and assume a benthic existence, typically spending their first 2 years in intertidal sand flat habitats near beaches where they were spawned. Adults return to deeper estuary bays and continental shelf waters after the breeding season (Thompson 1999).

CHALLENGES

Resource managers are concerned that the health of horseshoe crab populations along the northeastern coast of the United States is impacted by overharvesting (Widener and Barlow 1999; ASMFC 2001). New fishery regulations have been promulgated through individual states and the Atlantic States Marine Fishery Commission (ASMFC) fishery management plan for the East Coast (ASMFC 1998). In South Carolina, the harvest of horseshoe crabs is limited to the LAL industry, and a permit has been required since 1991. Recent studies suggest that between 10% and 20% of horseshoe crabs harvested for LAL production do not survive, even though the Food and Drug Administration (FDA) mandates that they be returned to the water alive. The main challenge to conservation in South Carolina is providing high quality habitat for horseshoe crabs.

CONSERVATION ACCOMPLISHMENTS

A fishery management plan is now in place for horseshoe crabs through the ASMFC. States must comply with goals of the plan and provide updates on their horseshoe crab status. In states that allow the harvest of horseshoe crabs for bait, stringent reductions have the lowered the allowable harvest from the high levels seen in the late 1990s to hopefully more sustainable levels. Crabs in the ACE Basin were once harvested in small numbers; however, South Carolina prohibited this activity in 1991. This was accomplished by improved monitoring and management of the commercial fisheries, effort reduction, state catch quotas, and seasonal and area closures. Increased funding has led to the establishment of a long-term trawl survey and standardized methodology for beach spawners and egg surveys, most of which takes place in Delaware Bay and offshore. Basic research has increased in recent years, and public awareness has been heightened to support conservation measures.

COMMENTS ON ASIAN HORSESHOE CRAB IMPORTATION

In 2013, prompted by recent importations of Asian horseshoe crab as bait in northern states (e.g., New York), the ASMFC passed a resolution intended to curtail this practice. Several concerns

were listed, including the potential introduction of parasites and diseases into the native *Limulus* populations, potential toxic effects from one species if ingested, and threats to the populations in Asia which are thought to be in serious decline. In addition, South Carolina prohibits the importation of the giant Asian horseshoe crab, *Tachypleus gigas*, the Asian horseshoe crab *Tachypleus tridentatus*, and the mangrove horsehoe crab, *Carcinoscorpius rotundicata*, along with other marine and estuarine species not already found in the wild or native to South Carolina. (For more information, see South Carolina Codes of Laws Sections 50-5-45 and 50-16-20).

CONSERVATION RECOMMENDATIONS

- Determine the long-term trends in the sizes of horseshoe crab spawning stocks, and investigate how these trends relate to environmental and other factors such as harvesting and LAL bleeding practices.
- Determine the nutritional importance of horseshoe crab eggs and larvae for shorebirds and how this is influenced by habitat change.
- Avoid beach renourishment activities during the horseshoe crab spawning season due to the importance of low energy beachfront as spawning and juvenile nursery habitat for horseshoe crabs.

MEASURES OF SUCCESS

Measures of success will be reflected as stable population trends for horseshoe crabs in South Carolina as well as the wildlife species, particularly shorebirds, that depend upon their eggs and larvae as food sources.

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