

Protecting Horseshoe Crab Habitat

Each spring adult horseshoe crabs migrate from deep bay waters and the Atlantic continental shelf to intertidal sandy beaches to spawn. Horseshoe crabs are an important food source for migrating shorebirds that feed on the eggs, for migrating fish that feed on the eggs and larvae and for Atlantic loggerhead turtles that feed on horseshoe crabs while using the Chesapeake Bay as a summer nursery area. In addition, horseshoe crabs are critical to the biomedical industry that uses their blood. A chemical obtained from horseshoe crab blood (*Limulus* amoebocyte lysate or LAL) is used to determine the safety of medical products for human use. Horseshoe crabs are slow to mature and can be easily harvested during the spawning season. As such, they may be susceptible to overharvest.

Horseshoe crab harvesting for bait in other fisheries such as American eel and conch as well as evidence of localized population declines occurring within Delaware Bay in the late 1990's raised concerns about the status of horseshoe crabs. As a result, the Atlantic States Marine Fisheries Commission (ASMFC) developed an interstate Fishery Management Plan (FMP) to conserve and protect the horseshoe crab resource. Since the plan's approval in 1998, states have implemented mandatory reporting of horseshoe crab landings, reduced

harvest of horseshoe crabs, initiated long-term monitoring programs necessary for stock status information, and made progress in identifying important horseshoe crab habitat. This article focuses on the progress made by Atlantic states in identifying important spawning and nursery habitat of horseshoe crabs.

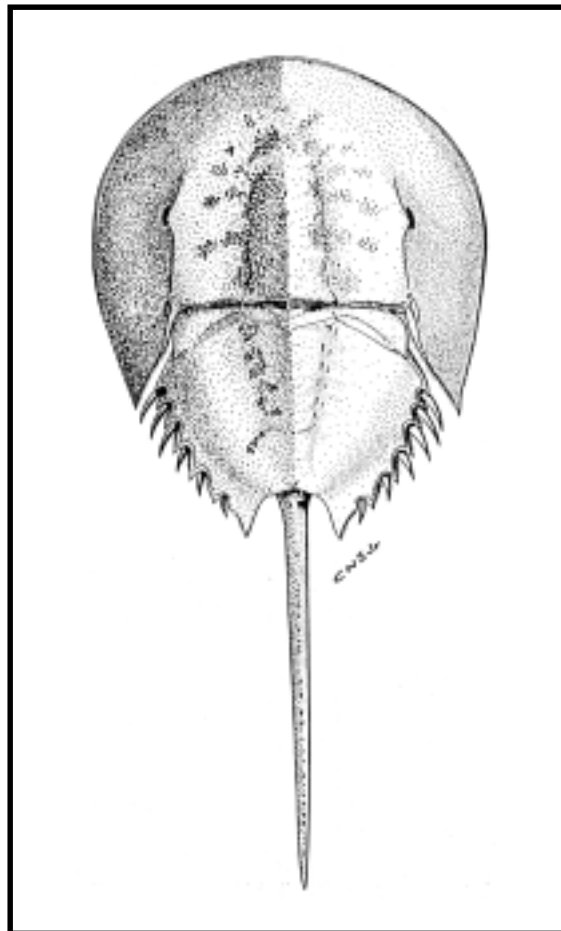


Figure 1. Horseshoe crab. Artwork courtesy of Carl N. Shuster Jr.

Horseshoe Crab Habitat

Horseshoe crabs (*Limulus polyphemus*) are benthic, or bottom-dwelling, arthropods that use both estuarine and continental shelf habitats (Figure 1). The horseshoe crab is an ecological generalist and although it is called a "crab," it is not a true crab, but rather is more closely related to spiders. North Atlantic horseshoe crabs are found from Maine to the Yucatan Peninsula, with the largest population of spawning horseshoe crabs in the world found in the Delaware Bay.

Beach areas provide spawning habitat for horseshoe crab adults. Horseshoe crabs prefer beaches within estuaries, such as Delaware and Chesapeake Bay, because they are low energy environments and offer protection from the surf. Beach habitat includes porous, well-oxygenated sediments to support egg survival and development. In particular, beach morphology, such as grain size, is an important factor because it determines oxygen, temperature and moisture on a beach. Eggs buried too high on the beach will dry out and those buried

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too low won't have enough oxygen. Spawning habitat varies throughout the horseshoe crab range. In Delaware, New Jersey and Massachusetts, beaches tend to be coarse-grained and well-drained in contrast to Florida beaches, which tend to be fine-grained and poorly drained. Furthermore, a Habitat Suitability Index (HSI) model was developed by the U.S. Fish and Wildlife Service (USFWS) and U.S. Army Corps of Engineers for identifying horseshoe crab spawning habitat within Delaware Bay. The HSI is a measure of physical variables including beach slope, grain size, depth of sand, and sediment moisture, that identify suitable sites for horseshoe crab spawning. The HSI model continues to evolve and improve based on new information.

Spawning generally occurs from March through July, with peak activity occurring on evening new and full moon high tides. Horseshoe crabs spawn multiple times per season, laying 3,650 to 4,000 eggs in a cluster. Adult females lay an estimated 88,000 eggs per year. Of the habitats used by horseshoe crabs, beaches provide the most critical habitat as this is where spawning and egg deposition occur.

In addition to beaches, nearshore, shallow water, intertidal, and subtidal flats are considered essential habitat for the development of juvenile horseshoe crabs. Shallow water areas of bays provide important nursery habitat where juveniles spend their first two years on intertidal sand flats. Older juveniles and adults are found in subtidal areas. During spawning periods, adults are found in bay areas adjacent to spawning beaches where they feed on bivalves (e.g., clams). In the fall after spawning, adults either remain in the bay areas or migrate to deeper water in the Atlantic Ocean to overwinter on the continental shelf. In addition, deep water areas are used by larger juveniles and adults to forage for food. Results from trawl surveys in the northeast found most adults in water depths less than 30 meters.

The primary threats to habitat include coastal erosion and human development particularly shoreline stabilization structures such as bulkheads and revetments along the estuaries of the Atlantic Coast. In addition, water quality issues like oil spills during spawning seasons, contaminants like mercury, lead, zinc and cadmium in some coastal estuaries, and red tide events all potentially impact horseshoe crab habitat particularly with regard to juveniles.

Benthic Sampling Programs

Most Atlantic states currently have benthic sampling programs in place for gathering information on horseshoe crabs. States have modified existing monitoring programs, most of which are trawl surveys, to collect horseshoe crab data specifically needed for assessments such as number, weight, prosomal width by sex of individuals collected. While information from these benthic sampling programs are primarily intended to collect key information for horseshoe crab stock assessments, they are also useful for determining horseshoe crab distribution and identifying important horseshoe crab habitat. Jim Berkson of Virginia Tech is also leading a multistate benthic trawl survey with financial

assistance from many of the Atlantic coast states as well as the USFWS and National Oceanic and Atmospheric Administration (NOAA) Fisheries.

Identification of Habitat

Because protection of essential habitat such as spawning beaches and juvenile nursery habitat is vital to the continued survival of horseshoe crabs, each state was required in the ASMFC FMP to identify potential horseshoe crab habitat, including both spawning and nursery areas. Each state is also encouraged to categorize and prioritize essential horseshoe crab habitat (both spawning and nursery habitat) within areas of its jurisdiction to focus effective protection and conservation efforts.

Pilot survey programs for spawning and egg densities were designed and conducted in Delaware Estuary in 1999 with support from a State Partnership Program including New Jersey, Delaware, Maryland and the U.S. Geological Service. Spawning crab surveys in Maryland and New Jersey utilized volunteers to help observe and report information on horseshoe crab spawning via a toll-free phone number or a web site. This volunteer effort has been very successful and has led to identification of numerous spawning sites. As a result, several states have incorporated a public reporting component as part of their spawning survey programs.

Here are some examples of the progress made by Atlantic states and federal agencies to identify potential horseshoe crab habitat.

Delaware, New Jersey, and Maryland

Delaware, New Jersey, and Maryland have identified horseshoe crab nursery and spawning habitat for Delaware Bay. Maryland has been implementing pilot spawning surveys since 1994 to delineate spawning habitat, determine the relative importance of each spawning area, determine the temporal trends in spawning activity, and provide public outreach/education. New Jersey reports that horseshoe crab nursery habitat is beginning to be identified through a small trawl survey in nearshore waters of Delaware Bay. Delaware continues to participate in and provide support for the Delaware Bay spawning survey. Maps showing the relative abundance of horseshoe crabs by sampling location in Delaware Bay will be updated annually (Figure 2). In conjunction with the USGS, Delaware conducts a multi-scale habitat modelling project for the entire Delaware Bay combining a geographic information system (GIS)-based model, LIDAR (light detection and radar) and field collected habitat characterization data. Delaware is also mapping historic sandy beach habitat areas from 1937-2002 and continues to conduct detailed evaluations of beach replenishment impacts on horseshoe crab spawning habitat.

New Hampshire

New Hampshire has been conducting a survey to identify potential horseshoe crab habitat in Great Bay Estuary

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Figure 2. Map showing the juvenile (<160mm) horseshoe crab distribution in Delaware Bay as measured by 30-foot trawl sampling for the years 1990 - 2001.

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since 1998. Five potential spawning sites identified from the 2000 survey, were visited in the 2002 survey and horseshoe crabs were observed at all 5 locations.

Maine

Maine's 2002 spawning survey was undertaken through a joint effort of Maine's Department of Marine Resources, several coastal watershed volunteer monitoring groups and private contractors to update the previous assessment conducted in 1977. Maine's survey results indicate there are eight spawning/nursery areas in its territory with significant spawning occurring in only five. Maine will continue to conduct surveys to determine horseshoe crab distribution in its waters in 2003. In addition, a tagging study was conducted in Taunton Bay to assess abundance, track repeat spawners on successive days and to attempt to gauge movement of individuals within and outside the bay.

Rhode Island

Based on data collected from a standardized spawning beach survey conducted from 2000-2002, Rhode Island has identified 64 potential horseshoe crab spawning areas in Narragansett Bay, RI Sound, Block Island Sound and the South Shore Coastal Ponds. The spawning beach survey is planned for the 2003 spawning season.

Connecticut

Connecticut used distribution data from surveys in 1999-2001 to identify potential habitat including 47 cove complexes. The cove complexes were assigned to categories of preferred spawning habitat (coves with crab densities above the median value for all sites), secondary spawning habitat (coves with crab densities at or below the median value for all sites), probable or potential spawning habitat, and habitat probably not suitable for spawning. Fifty per cent of the coves were designated as preferred habitat and 27% as secondary spawning habitat.

Massachusetts

In Massachusetts, horseshoe crab nursery and spawning habitat have been identified for approximately 60% of the state's coastline. In 2002, a questionnaire was sent to harvesters requesting information about spawning and nursery areas. In 2003, the public is being asked to help in identifying additional spawning areas.

New York

New York has begun to identify horseshoe crab spawning sites. Four sites have been identified so far, and New York plans to continue working with industry to further identify spawning locations.

Virginia

Identification of potential horseshoe crab spawning beaches in Virginia ran from 1999-2002 as part of a study conducted by the Virginia Institute of Marine Science to assess beaches in

Chesapeake Bay based on the habitat suitability index (HSI) developed in Delaware Bay. Results of the study found that Chesapeake Bay sites had a significantly higher sediment moisture content and steeper beach slope than spawning areas in Delaware Bay and Florida. Thus, the HSI developed for Delaware Bay is considered not applicable to Chesapeake Bay beaches. To help identify spawning habitat in Virginia, the Virginia Marine Resources Commission is providing a 24-hour toll-free telephone number during May, June and July for individuals to report horseshoe crab spawning activity.

North Carolina

Limited information is currently available on horseshoe crab spawning and nursery habitat in North Carolina. A volunteer survey program to identify horseshoe crab spawning areas was started in 2002 and is planned for 2003.

South Carolina

South Carolina has conducted several spawning studies (1997, 1999, 2001, and 2002) and has implemented a toll free hotline to report horseshoe crab spawning. In addition, South Carolina has developed a GIS database of potential spawning habitat. Spawning and nursery habitat have been classified as primary, secondary, or potential. Juvenile nursery habitat has been identified at sites on Harbor Island, SC.

Georgia

Since 1999, Georgia has conducted a survey of its entire coast for migrating shorebirds and horseshoe crab spawning locations. Observations suggest that Georgia has many sites where small numbers of coupled crabs have been observed.

Florida

Florida received a research grant to solicit public participation to identify spawning beaches; collect abundance, size and sex data; and sample horseshoe crabs for genetic analysis. The Florida Fish and Wildlife Conservation Commission is providing a toll-free telephone number for individuals to report horseshoe crab nesting activity and an online survey form for people to fill out to report horseshoe crab spawning beach information.

Federal Agencies

Federal agencies are also taking action to protect horseshoe crab habitat, often in cooperation with and supporting state efforts. NOAA fisheries continues to maintain the Carl N. Schuster Jr. Horseshoe Crab Reserve which was implemented in 2001 to protect known horseshoe crab nursery habitat in federal waters off the mouth of Delaware Bay. Dredging and trawling for horseshoe crabs are prohibited in the reserve and possession of horseshoe crabs on any vessel with a trawl or dredge onboard is prohibited in the reserve.

The USGS is conducting a baywide tagging study to estimate migration, abundance, and survival of horseshoe crabs in Delaware Bay. The USGS participates in the Delaware Bay

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Spawning Survey and is working cooperatively with Delaware and other organizations to study the effect of beach nourishment on horseshoe crab habitat use.

Through the Delaware Estuary Project, the USFWS has provided staff, equipment and funding to Delaware and New Jersey to support the Delaware Bay horseshoe crab spawning and egg surveys.

Other Habitat Protection Measures

Under the FMP each state fisheries agency is requested to actively intervene to the extent of its authority to ensure that federal, state, and local regulatory agencies are aware of the potential loss in horseshoe crab productivity associated with water quality degradation and habitat loss. States have taken different approaches to accomplish this. Delaware's Division of Fish and Wildlife routinely comments on dredge permit applications and advises that the dredging window specified in the FMP be followed, unless site-specific information is available that supports an alternative strategy. Maine has an environmental coordinator who reviews and comments on all applications for alteration of aquatic habitat and pays particular attention to proposed alterations in known horseshoe crab spawning and nursery habitats. Massachusetts sends a letter every year to various regulatory agencies informing them of the Horseshoe crab FMP and its recommendations regarding habitat conservation and restoration. North Carolina Division of Marine Fisheries reviews all coastal development permits and comments on those that may have a negative effect on fishery habitat as well as individual species.

The FMP recommends that states consider obtaining land adjacent to critical spawning beaches to ensure the long-term protection of these beaches, for example through acquisition, deed restrictions, or conservation easements. In addition, states are encouraged to restrict all-terrain vehicles and beach watercraft activity such as jet skis on spawning beaches during the spawning season to minimize mortality of horseshoe crab embryos and

larvae. While most states have focused their efforts and resources on identification of important horseshoe crab habitat, some states are beginning to consider these additional actions.

Habitat Restoration

Beach nourishment may restore or improve spawning habitat, as long as measures are implemented to minimize adverse impacts on horseshoe crabs and other resources (see report **Beach Nourishment: A Review of the Biological and Physical Impacts**, by Karen Greene, ASMFC Habitat Management Series #7, 174 pp., available at www.asmfc.org). The FMP includes recommendations for locating beach nourishment mining areas offshore to minimize impacts on essential juvenile habitat and that construction activities avoid periods of critical spawning and juvenile development for horseshoe crabs. Furthermore, beach nourishment activities should be implemented in cooperation with appropriate agencies to ensure that critical spawning beaches are not lost to coastal erosion associated with residential and commercial development adjacent to spawning habitat.

New Habitat Research

With funds from New Jersey, the ASMFC will be administering a research grant for underwater video monitoring of horseshoe crabs. The benthic sled equipped with a video camera and geographic positioning system (GPS) will allow scientists to document horseshoe crabs in their underwater environment. This information will be key in better understanding habitat needs and developing strategies to protect such habitat. The video monitoring is planned for this year's prime spawning season, from May to June. A final report is due in early Fall 2003.

For more information on horseshoe crab resource conservation and management, contact Brad Spear, FMP coordinator, at bspear@asmfc.org or (202) 289-6400. The horseshoe crab FMP, Addendum I, and Addendum II are available at the ASMFC's web site: www.asmfc.org.

Submerged Aquatic Vegetation Brochure Available

The Atlantic States Marine Fisheries Commission (ASMFC) has produced a color brochure on submerged aquatic vegetation (SAV). The brochure describes the importance of SAV and how fishermen and boaters can help protect it. The ASMFC's interest in SAV stems from the important role this habitat plays in critical life history stages of many ASMFC managed species. SAV provides food and shelter for many fish species and their prey, stabilizes bottom sediments and cycles oxygen and nutrients.

To enhance protection of SAV, the ASMFC adopted an SAV policy in 1997 with the goal of preserving SAV, and ultimately achieving a net gain in SAV distribution and abundance. Here are

some examples included in the brochure of what boaters and fishermen can do to protect SAV:

- Wherever possible, steer clear of SAV beds when in a boat.
- When around SAV beds, go slowly to avoid stirring up sediments.
- Stay in designated navigation channels and try to find out where SAV beds are located.
- In SAV beds, avoid using gear which can uproot SAV.
- Always use pump stations to get rid of waste.

To request a brochure or for further information, contact Carrie Selberg, ASMFC Habitat Specialist, at 202-289-6400.

Impact of Noise on Marine Mammals and Fish Remains Unclear

The ocean environment has always included an abundance of natural noises, such as the sounds generated by rain, waves, earthquakes, and sea creatures. However, a growing number of ships and oil rigs, as well as increased use of sonar by navies and researchers, is adding to the natural noise that already surrounds marine life. Although noise in the sea has increased steadily since the Industrial Revolution, there is little information on exactly how noisy it has become or how marine mammals and other marine organisms including fish react to the noise. Nevertheless, recent episodes in which dolphins and whales have beached themselves while human-generated sounds were being deployed nearby have raised questions about the impact of ocean noise.

A new report from the National Academies' National Research Council (NRC) says that a single federal agency should be put in charge of monitoring marine noise and should fund research into how human-generated sounds may affect marine mammals and other sea life. Although the main focus of the report is on marine mammals, impacts to fish and other marine organisms are reviewed and considered because of their role in the marine food web and ecosystem.

Fish use sound to communicate and learn about their environment. For example in many fish species, chorusing behavior is believed to play an important role in spawning by attracting females to spawning sites. Fish choruses occur when a large number of animals call at the same time. Fish choruses are known to raise the ambient noise levels in certain locations, at certain times of the day, and at certain times of the year. More information is needed to evaluate the possible impact of human-generated sounds on fish communication and behavior.

The report, **Ocean Noise and Marine Mammals**, was compiled by the NRC's Ocean Studies Board's Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals. The study was requested by the National Ocean Partnership Program, a federal interagency project, and sponsored by the Office of Naval Research, the National Oceanic and Atmospheric Administration, the National Science Foundation, and the U.S. Geological Survey. The report can be read online at: http://www.nap.edu/catalog/10564.html?onpi_newsdoc021003.

Sources: National Academy of Sciences press release, February 10, 2003; and Ocean Noise and Marine Mammals..

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