

Species Profile: Horseshoe Crab

Bait, Birds and Biomedical: A Glimpse into the World of Horseshoe Crabs

Introduction

Horseshoe crabs (*Limulus polyphemus*) are utilized by a diverse range of interests, which makes management of the resource complicated but interesting. American eel and whelk fisheries use horseshoe crabs as their primary bait, but the crabs are also an important resource for migrating shorebirds and for the pharmaceutical industry. Red knots, a candidate species under the Endangered Species Act, feed on horseshoe crab eggs in the Delaware Bay on their long migration from South America to the Arctic. Horseshoe crab blood is used by the biomedical industry to produce Limulus Amoebocyte Lysate (LAL), an important tool for detecting contaminants in medical devices and drugs.

The Commission's Adaptive Resource Management (ARM) Framework takes into account these various uses of horseshoe crabs to set a sustainable harvest level. However, the future of this multi-tasking model is uncertain due to budget constraints that have curtailed the primary abundance survey used by the ARM, namely the Virginia Tech Horseshoe Crab Trawl Survey.

Life History

Horseshoe crabs are a marine arthropod found along the Atlantic coast from northern Maine to the Yucatan Peninsula and the Gulf of Mexico. Adults either remain in estuaries or migrate to the continental shelf during the winter months. Migra-

tions resume in the spring when the horseshoe crabs move to beach areas to spawn. Juveniles hatch from the beach environment and spend the first two years in nearshore areas.

Spawning usually coincides with the high tide during the full and new moon. Breeding activity is consistently higher during a full moon and is also greater during the night. Adults prefer sandy beach areas within bays and coves that are protected from surf. Eggs are laid in clusters or nest sites along the beach with females laying approximately 90,000 eggs per year in different egg clusters (although only about ten will reach adulthood).

The eggs play an important ecological role in the food web for migrating shorebirds. The Delaware Bay Estuary is the largest staging area for shorebirds in the Atlantic Flyway. An estimated 425,000 to one million migratory shorebirds converge on the Delaware Bay to feed and rebuild energy reserves prior to completing their northward migration. It is estimated that red knots double their mass (by consuming horseshoe crab eggs) before they have sufficient fuel to complete the journey north.

Commercial Fisheries and Biomedical Harvest

In addition to their role as a food source for birds, horseshoe crabs provide bait for commercial American eel and whelk

Species Snapshot

Horseshoe Crab
Limulus polyphemus

Management Unit:
New Hampshire to Florida

Interesting Facts:

- Horseshoe crabs were once called "horsefoot crabs" because of their resemblance to a horse's hoof.
- Their scientific name "polyphemus" alludes to a one-eyed giant in Greek mythology, due to the fact that people thought they only had one eye (they actually have ten).
- Horseshoe crabs have existed for nearly 400 million years, predating flying insects, dinosaurs, and man.
- Horseshoe crabs are more closely related to spiders than crabs.
- There are 4 living species of horseshoe crabs and only 1 of those inhabits the western Atlantic Ocean. The other 3 are found in the Pacific Ocean.

Stock Status: Unknown



(also known as conch) fisheries along the coast. Their unique blood is also used by the biomedical industry to produce LAL.

In the early days of the horseshoe crab fishery (1850s-1920s), the species was primarily used for fertilizer and livestock, with annual landings of between 1.5 and 2 million crabs. Harvest was low for about twenty years, until the 1970s, when harvest ranged from 20,000 pounds to greater than two million pounds until the 1990s. Since the discovery of the success of horseshoe crabs as bait in the eel and whelk fisheries, commercial harvest has been used primarily for that purpose. Increased need for bait in the whelk fishery likely caused an increase in horseshoe crab harvest in the 1990s, with a peak of nearly six million pounds in 1997. Since that time, effective management has reduced the harvest of horseshoe crabs. Preliminary coastwide commercial landings for bait in 2012



Photo by Laurel Wilkerson, USFWS

were approximately 729,000 horseshoe crabs. Trawls, hand harvests, and dredges make up the bulk of commercial horseshoe crab bait landings.

Horseshoe crabs are effective as bait in the whelk and eel fisheries because of a chemical cue that is released by their flesh. Recent research conducted at the University of Delaware found that less horseshoe crab tissue is needed than previously thought to successfully attract the target species. The research tested artificial bait, which is an alginate-based mixture with horseshoe crab tissue and Asian shore crab meat (an abundant invasive species, not to be confused with Asian horseshoe crab). The artificial bait, which uses a 50:50 mixture of horseshoe crabs to Asian shore crabs, was found to be as successful as the 100% horseshoe crab mixture. In addition, the research also determined that male horseshoe crabs can be used in the artificial bait, which eliminates the need for eel and whelk fishermen to target female horseshoe crabs. The research is encouraging for the conservation of horseshoe crabs because using the artificial bait may lead to reduced harvest pressure.

Horseshoe crabs are also collected by the biomedical industry to support the production of LAL, a clotting agent that aids in the detection of human pathogens in patients, drugs, and intravenous devices. No other procedure has the same accuracy as the LAL test. Blood from the horseshoe crab is obtained by collecting adults, extracting a portion of their blood, and releasing them alive. Following bleeding, most crabs are returned to the waters where they were captured. However, since 2004, states have the ability to enter bled crabs into the bait market and count those crabs against the bait quota. In recent years, the total estimate of horseshoe crabs caught for medical usage is around 500,000 per year on the Atlantic coast. Estimated mortality on biomedical crabs not counted against state bait quotas has increased from about 45,000 crabs in 2004 to approximately 80,000 crabs in 2012.

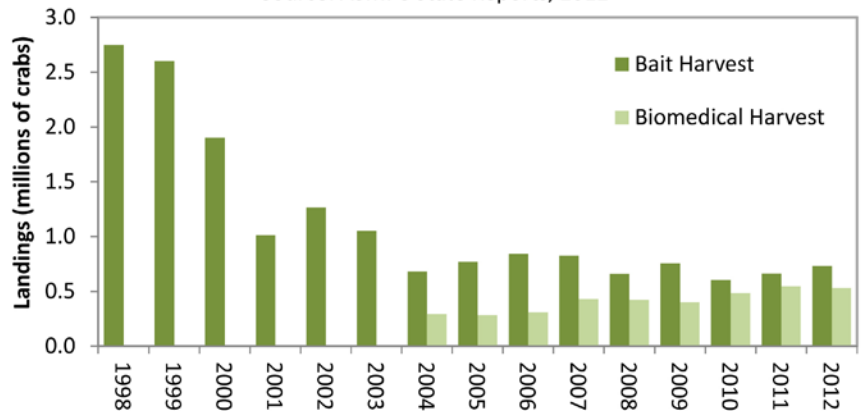
Stock Status

The status of the stock is unknown largely due to the lack of long-term data sets for commercial landings and stock abundance. However, the 2009 peer-reviewed benchmark stock assessment indicates that the Delaware Bay horseshoe crab population is experiencing positive population growth. Increasing trends were most evident for juveniles, followed by adult males. A significant increase in adult females was observed in the Virginia Tech Benthic Trawl Survey. These patterns are indicative of population recovery, given that horseshoe crab females take longer to mature than males. Positive trends in horseshoe crab numbers are also being seen in the Southeast region.

In contrast, the stock assessment showed declining abundance in New York and New England. Declines in the New England

Coastwide Horseshoe Crab Bait Landings & Biomedical Harvest

Source: ASMFC State Reports, 2012



Timeline of Management Actions: FMP (1999); Addendum I (2000); Addendum II (2001); Addendum III (2004); Addendum IV (2006); Addendum V (2008); Addendum VI (2010); Addendum VII (2012)

Please note the following details regarding biomedical harvest numbers:

- Harvest numbers include all horseshoe crabs brought to bleeding facilities, including those that were harvested as bait and counted against state quotas.
- Most of the biomedical crabs harvested are returned to the water after bleeding; a 15% mortality rate is estimated for all bled crabs.

population were also apparent in the 2009 assessment. The Commission's Horseshoe Crab Technical Committee believes decreased harvest quotas in Delaware Bay encouraged increased harvest in nearby regions. The Technical Committee recommends continued precautionary management to address effects of redirected harvest from Delaware Bay to outlying populations. Since the 2008 fishing season, New York and Massachusetts continue to adjust their regulations to address recent increased harvest in their respective waters.

Horseshoe crabs are currently undergoing a stock assessment update. The report is expected to be available in October 2013.

Atlantic Coastal Management

Horseshoe crabs are managed under the Interstate Fishery Management Plan for Horseshoe Crab (December 1998). The Commission established state-by-state quotas in all Atlantic states for crabs harvested for bait under Addendum I (2000). In 2006, in response to decreasing migratory shorebird populations, Addendum IV was approved. This enabled the Commission to reduce quotas in New Jersey and Delaware and added additional protection in Maryland and Virginia to increase horseshoe crab and egg abundance in and around Delaware Bay. These measures were in place from 2006 – 2012. In 2012, using its ARM Framework, the Commission's Horseshoe Crab Management Board approved a harvest limit of 500,000 Delaware Bay male horseshoe crabs and zero female horseshoe crabs for the 2013 season. The ARM Framework, established through Addendum VII, incorporates both shorebird and horseshoe crab abundance levels to set optimized harvest levels for horseshoe crabs of Delaware Bay origin. It was developed in recognition of the relationship between horseshoe crab eggs

and shorebirds in the Delaware Bay Region. The optimized harvest level is reevaluated annually, allowing for management to adapt to the changes in the population levels of horseshoe crabs and shorebirds as a result of the regulations. This model depends on the data obtained from the Virginia Tech Trawl Survey. In 2012, the survey was unable to sample the entire Delaware Bay area. In 2013, there is not enough funding for the trawl survey to occur. In the absence of this data, the ARM Working Group is exploring other options that would provide similar abundance estimates. These options include the fall Northeast Area Monitoring and Assessment Program survey and/or using mark-resight data from the spawning survey.

The uncertainty in the stock status of horseshoe crabs has moved some states to adopt more conservative management than is outlined in Addendum VII. For example, there has been a moratorium on horseshoe crab harvest in New Jersey since 2008. This moratorium has had impacts to surrounding states, increasing the occurrence of poaching and driving up the market price of crabs. In addition, the harvest controls on the Atlantic states have made it difficult for some whelk and eel fishermen to obtain enough bait for their use. Some fishermen have turned to using imported Asian horseshoe crabs as bait. The Commission has released a resolution expressing concern over this practice for a variety of human health and ecological reasons (see right). For more information, please contact Marin Hawk, FMP Coordinator, at mhawk@asmfc.org or 703.842.0740.

Resolution to Ban the Import and Use of Asian Horseshoe Crabs as Bait

Whereas, the Atlantic States Marine Fisheries Commission is comprised of representatives of the fifteen Atlantic coastal states and is charged with management of fisheries resources, marine, shell, and anadromous; and

Whereas, one of those fisheries resources is the Atlantic horseshoe crab (*Limulus polyphemus*) which is managed for its ecological services, use as bait, and in the biomedical industry; and

Whereas, horseshoe crabs are used as bait in fisheries for American eel and whelk fisheries; and

Whereas, bait shortages motivated seafood dealers in the State of New York to import 2,000 non-native Asian horseshoe crabs in 2011, and 7,400 kilograms of non-native Asian horseshoe crabs in 2012 for use as bait in state waters; and

Whereas, three species of Asian horseshoe crabs (*Tachypleus gigas*, *Carcinoscorpius rotundicauda*, and *Tachypleus tridentatus*) pose a potential threat to the marine resources and human health along the US Atlantic coast; and

Whereas, recent evidence presented in 2011 suggests that the populations of these three species of Asian horseshoe crabs are in decline; and

Whereas, it will take the US Fish and Wildlife Service up to a year to add the species to the Injurious Wildlife list of the Lacey Act so importation can be regulated on a federal level; and

Whereas, in the meantime measures should be put in place to address the issue; and

Whereas, one species of parasitic flatworm lays eggs in tough cocoons on the shell of the Asian horseshoe crab, which can easily survive and hatch even if the host crab is killed; and

Whereas, the introduction of such or similar parasites would have detrimental effects on the American horseshoe crab population, and

Whereas, detrimental impacts on American horseshoe crab populations will likely impact food availability for migratory shorebirds, including red knots; and

Whereas, one species of Asian horseshoe crab (*C. rotundicauda*) is known to contain the powerful, potentially painful, neurotoxin tetrodotoxin (TTX); and,

Whereas, the potential for TTX accumulation in commonly consumed seafood product (whelk and eel) and subsequent human illness is unknown; and

Now, therefore be it resolved that the Commission's Horseshoe Crab Management Board recommend to its member states that they take any and all action to ban the importation and use of Asian horseshoe crabs as bait as soon as possible.