Wildlife Populations: Horseshoe Crab

Background

Horseshoe crabs, *Limulus polyphemus,* are important to a diverse set of users. They lay their eggs on sandy beaches in spring and summer, and migrating shorebirds rely heavily on their eggs to supply energy required to complete their migration. Biomedical companies catch horseshoe crabs for their blood, from which they produce Limulus Amebocyte Lysate (LAL). LAL is used to detect contamination of injectable drugs and implantable devices; it is the most sensitive means available for detecting endotoxins, which are part of the outer membrane of the cell wall of certain bacteria, such as *E. coli* and *Salmonella*. Finally, horseshoe crabs are harvested commercially for bait to catch American eels, catfish, and whelk. Horseshoe crabs are a particularly important issue in New Jersey because the Delaware Bay is the center of horseshoe crab spawning abundance on the Atlantic coast.[1]

Adult horseshoe crabs winter in water 20 to 60 feet deep on the continental shelf. Increased water temperature and amount of daylight stimulate adult migration toward sandy beaches for spawning. The peak migration in the Delaware Bay generally occurs during the evening full moon tides in May and June. Females dig a shallow hole, ranging from 5 to 30 centimeters, below their bodies and deposit their eggs in clumps within the intertidal zone. Weather can negatively affect spawning by disrupting spawning sites, driving animals off the beach, diminishing the number of pairs able to spawn, or preventing them from coming to the beach at all.[2]

Horseshoe crabs molt numerous times as they grow from larval stage, shedding their exoskeleton at least 16 or 17 times before reaching sexual maturity. Horseshoe crabs require nine to 10 years to reach maturity, when they cease to molt, and may reach a maximum age of 20 years.[3]

Trends

Horseshoe crabs are currently managed under Addendum VII of the Atlantic States Marine Fisheries Commission (ASMFC) Fishery Management Plan for Horseshoe Crab,[4] (http://www.asmfc.org/species/horseshoe-crab). A recent (2013) stock assessment evaluated the status of several regional populations, including the Delaware Bay region.[5] High harvest levels during the 1990s led to rapid population declines in the mid-Atlantic region. Management actions taken in 2004 and 2006 halted the population decline, and stock assessment results indicate the Delaware Bay population of horseshoe crabs appeared to have stabilized.[6] There is concern however, that current abundance is not sufficient to support viable populations of species that depend on horseshoe crabs, such as the federally-listed red knot and other migratory shorebirds.[7] One objective of current horseshoe crab management, therefore, is to increase abundance of horseshoe crabs in the Delaware Bay region.

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Within the Delaware Bay region, there are a number of surveys that provide information on population status. Although variability exists among the surveys, common trends are evident. In particular, longer time series indicate a rapid decline in abundance during the 1990s followed by apparent stability. Trawl surveys that can be evaluated by sex indicate that neither male nor female abundance has a consistent increasing or decreasing trend, over the last 5 years.[8] The Delaware Bay Spawning Crab Survey similarly shows no significant trend in spawning density of either sex (1999 through 2013).[9] Harvest restrictions implemented in 2004 and 2006 have significantly reduced horseshoe crab harvest both coastwide and in the Delaware Bay region relative to the peak harvests in the late 1990s. The lack of population response to these management efforts may be a result of horseshoe crab life history characteristics and/or other sources of mortality (e.g., bycatch, illegal harvest, lysate bleeding, environmental trends, ecosystem interactions), which have been difficult to quantify and account for in management of this species. For example, large bait harvests of the 1990's focused primarily on breeding-age crabs, particularly females which are favored for bait.[10] Population recovery following these large harvests was expected to be slow as horseshoe crabs are thought to take 10 years to reach spawning age. Population growth has also been slowed by continued bait harvest. In addition, recent studies have observed that horseshoe crab mortality from LAL bleeding ranges from 8-29% under normal industry practices and increases with additional stress.[11] Further, a recent study found sublethal effects of bleeding include behavioral and physiological changes that could decrease overall fitness.[12] Coupled with a 78% increase in demand for LAL since 2004[13], these lethal and sublethal effects associated with LAL bleeding could be hindering population response to management actions. Reduced food availability may also be affecting population recovery. For instance, there has been a significant decrease in surf clam (*Spissula solidissima*) populations, a major prey item of horseshoe crabs, in the mid-Atlantic region over the last two decades.[14] Another factor that may be inhibiting population growth is loss of habitat, particularly spawning beaches in Delaware Bay. Both New

Jersey and Delaware are taking steps to protect and enhance bayshore beaches to ensure suitable spawning habitat.

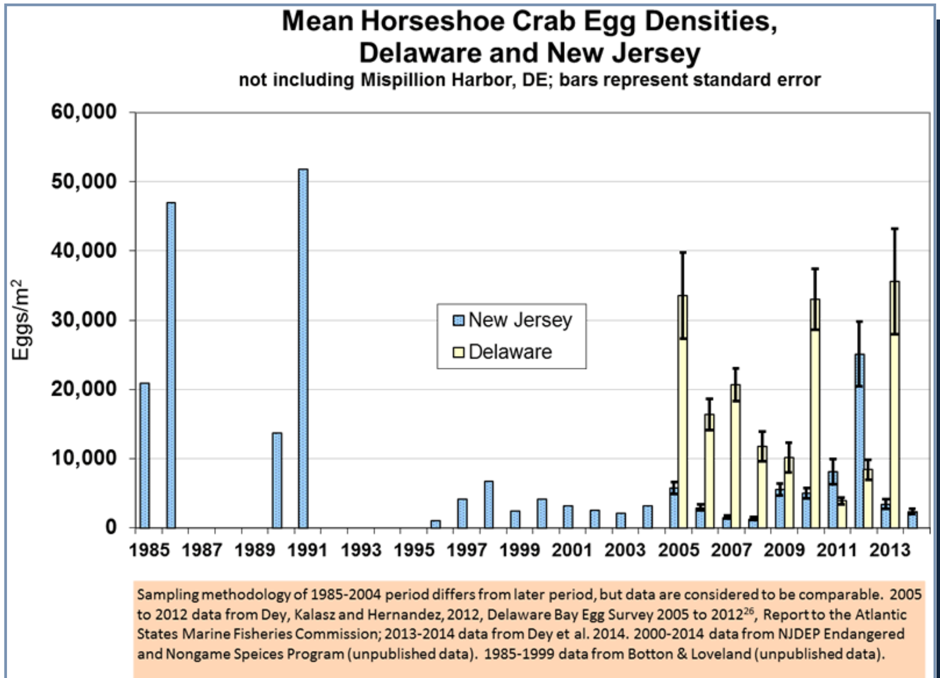

Figure 1: Mean Horseshoe Crab Densities

Because of the importance of horseshoe crab eggs as a primary food source for several species of migratory shorebirds, studies of horseshoe crab egg density have been performed since 1985. These studies have found a dramatic decline in horseshoe crab egg density from peak numbers in 1991, which corresponds with the period of intense harvest during the mid-1990s and early 2000s. Egg surveys conducted in Delaware and New Jersey found essentially no change in egg density from 2005 through 2014 [15](See Figure 1). Mispillion Harbor, DE, continues to be an important shorebird foraging area with very high egg densities. The harbor is protected in all weather conditions and may enjoy earlier, warmer water temperatures; both aspects favor horseshoe crab spawning.

Outlook and Implications

Management efforts by the states and ASMFC led to a decrease in harvest of horseshoe crabs from over 2 million per year (coastwide) in the late 1990s to around 500,000 per year or less in 2009-2012[16] (See Figure 2) In 2013, harvest increased to 698,561[17] primarily due to the implementation of an all-male harvest in the Delaware Bay region and the larger quota of male crabs allowed in Virginia and Maryland. The importance of horseshoe crabs to species such as the red knot requires that horseshoe crab abundance be sufficient to support not only the human use, but needs of other species as well. To achieve these goals, the ASMFC developed a multispecies management framework that includes horseshoe crabs and red knots.[18] In 2013, the Adaptive Resource Management (or ARM) model was implemented, which identifies an optimum harvest strategy for the Delaware Bay region, considers the utility of crabs to both ecosystem dynamics and human use. The current harvest option prohibits harvest of female crabs from the Delaware Bay region, but allows a harvest of ~600,000 males crabs allocated among the states based on historic performance. Given their life history, population growth will be slow and may be hindered by factors such as continued human use, habitat loss, food availability, illegal harvest and incidental mortality; however, NJ DEP is taking steps, such as a harvest moratorium and beach replenishment, to protect this keystone species for the maximum benefit of all users.

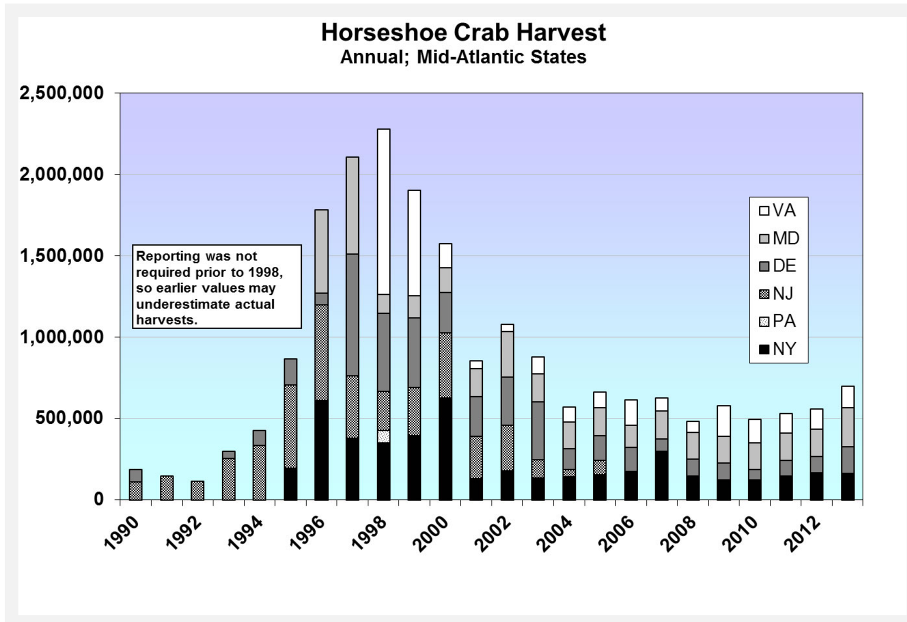

Figure 2: Horseshoe Crab Harvest

More Information

For more information, visit www.asmfc.org, mouse over "Fisheries Management" and select "Horseshoe Crab."

References

[1]Hata, D and J. Berkson. 2003. Abundance of horseshoe crabs (*Limulus polyphemus)* in the Delaware Bay area. *Fishery Bulletin* 101:933-938.

[2]Walls, E. A., J. Berkson, and S. A. Smith. 2002. The Horseshoe Crab, *Limulus polyphemus:* 200 Million Years of Existence, 100 Years of Study.

[3]Walls, et al., 2002

[4]Atlantic States Marine Fisheries Commission (ASMFC) 2012. Addendum VII to the interstate fishery management plan for Horseshoe Crabs for public comment. Adaptive Resource Management Framework. Approved February 2012. 10 pp. http://www.asmfc.org/uploads/file/hscAddendumVII_Feb2012.pdf

[5]Atlantic States Marine Fisheries Commission (ASMFC) 2013. Horseshoe crab stock assessment update. 73 pp.

[6]ASMFC 2013.

[7]ASMFC 2013.

[8]ASMFC 2013.

[9]Zimmerman, J., E. Hale, D. Smith, S. Bennett. 2014. Horseshoe Crab Spawning Activity in Delaware Bay: 1999 – 2013. Report to the Atlantic States Marine Fisheries Commission's Horseshoe Crab Technical Committee. 16 pp.

[10]ASMFC 2012.

[11]Anderson, R.L., W.H. Watson III, and C. Chabot. 2013. Sublethal behavioral and physiological effects of the biomedical bleeding process on the American Horseshoe Crab, Limulus polyphemus. Biological Bulletin 225:137-151.

[12]Anderson et al., 2013.

[13]ASMFC, 2013.

[14]New Jersey Division of Fish and Wildlife, "Inventory of New Jersey's Surf Clam (Spisula solidissima) Resource, Period Covering July 1, 2005 to June 30, 2009. Report submitted to the National Oceanic and Atmospheric Administration on September 24, 2010. (Accessed online 2/23/2015: http://www.greateratlantic.fisheries.noaa.gov/StateFedOff/grantfactsheets/NJ/FINAL%20REPORTS/FINAL%20NA05NMF4071146.pdf)

[15]Dey, A. D., M. Danihel, L. Niles, K. Kalasz, G. Morrision, B. Watts, H. Sitters. 2014. Update to the status of the red knot (Calidris canutus rufa) in the Western Hemisphere, August 2014. Draft Report 9-5-14, 11 pages.

[16]Smith, D.R., C. P. McGowan, J. P. Daily, J. D. Nichols, J. A. Sweka and J. E. Lyons. 2013. Evaluating a multispecies adaptive management framework: must uncertainty impede effective decision-making?
Journal of Applied Ecology 50(6):1431-1440.

[17]ASMFC, 2013.

[18]ASMFC 2009. A Framework for Adaptive Management of Horseshoe Crab harvest in the Delaware Bay Constrained by Red Knot Conservation. . Stock assessment report no 09-02 (Supplement B) of the Atlantic States Marine Fisheries Commission. 46 pp.

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