

Chapter 7.6

State of Horseshoe Crabs in Maryland Coastal Bays

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Abstract

Horseshoe crabs and their eggs are a critical food source for many species including sharks, turtles and shore birds. Commercially the species is harvested for bait and for a protein in their blood, *Limulus Amebocyte Lysate*, which is valuable and widely used in the biomedical industry. Development of coastal habitat is the major threat to the population. Shoreline armoring and erosion decreases available spawning habitat. An annual spawning survey was initiated in 2002 to determine spawning habitat and crab abundance. The Interstate Fishery Management Plan for Horseshoe Crabs recently reduced allowed harvests and established a horseshoe crab sanctuary at the mouth of the Delaware Bay.

Introduction

Horseshoe crabs, *Limulus polyphemus*, are characterized by high fecundity, high egg and larval mortality, and low adult mortality (Botton & Loveland, 1989; Loveland, et al, 1996). They spawn multiple times per season and per tide, laying approximately 3,600 to 4,000 eggs in a cluster (Schuster, 1950; Shuster & Botton, 1985). Based on different methods of estimating maximum age, adults may live as long as 16 to 19 years.

Populations are influenced by harvesting levels, habitat loss and shorebird predation. During the first half of the 20th century, threats to the horseshoe crab included overharvesting primarily for fertilizer and animal feed. Large numbers of crabs were collected on Mid-Atlantic beaches or in nets during the spawning season to meet this demand. However, most of the evidence of overharvesting is anecdotal because historical data on horseshoe crab harvests is often incomplete. Watermen were not required to report their catch until the late 1990's.

The threats to horseshoe crab populations have changed dramatically as a result of expanding fisheries. Since the early 1990's, horseshoe crabs have been harvested for bait to catch American Eel (*Anguilla rostrada*) and whelk (*Busycon spp.*) in Maryland and the rest of the Mid-Atlantic region. The increases in horseshoe crab harvests throughout the late 1990's are a result of an expanding whelk fishery. Increasing demand for whelk in Asian and European markets was the driving force behind the expansion. In addition, horseshoe crabs are used for the biomedical industry and have lost valuable spawning habitat to coastal development.

Additionally, this species is harvested by the biomedical industry to produce a valuable medical product critical to maintaining the safety of many drugs and devices used in medical care. A protein in the blood called Limulus Amebocyte Lysate (LAL) is used by pharmaceutical and medical device manufacturers to test their products for the presence of endotoxins, bacterial substances that can cause fevers and even be fatal to humans. A horseshoe crab's blood has a blue to blue-green color when exposed to the air. The blood is blue because it contains a copper-based respiratory pigment called hemocyanin.

Development of coastal habitat has increasingly become an important issue for horseshoe crabs. Sandy beaches are essential spawning habitat for horseshoe crabs and nearshore shallow water habitats (i.e., mud and sand flats) are important nursery grounds for juvenile crabs. Human activities can reduce the available habitat horseshoe crabs need for reproduction and larval development to maintain their populations over time. Several types of shoreline erosion control structures commonly used to protect property reduce available spawning habitat. These structures include bulkheads, groins and rip rap. Each of these shoreline control structures commonly referred to as "armoring" or "hardening", is designed to protect the shoreline from the effects of erosion. However, they also block access to spawning beaches, eliminate sandy beach habitat or entrap and strand spawning crabs during times of high wave energy. Coastal development activities combined with shoreline erosion are contributing to the continued deterioration of coastal habitats essential to spawning horseshoe crab populations.

Data Sets

Cooperative Horseshoe Crab spawning study since 2002 Maryland Coastal Bays Program, Maryland Department of Natural Resources, and volunteers

Horseshoe Crab Indicator

None

Status of Horseshoe Crab

The Interstate Fishery Management Plan (FMP) for Horseshoe Crabs was approved by the Atlantic States Marine Fisheries Commission (ASMFC), on October 22, 1998. The fishery management plan is designed as a tool to guide individual States to conserve and protect the horseshoe crab resource at a population that sustains its ecological and economic benefits. Contained within the fishery management plan are requirements for managing the horseshoe crab harvests and monitoring populations.

Requirements of the Horseshoe Crab fishery management plan Addendum 1 include:

- States must reduce horseshoe crab landings to 25% below their reference period landings.
- States with more restrictive harvest limits are encouraged to maintain those limits.
- Encourage the National Marine Fisheries Service (NMFS), to establish a horseshoe crab sanctuary at the mouth of the Delaware Bay estuary.

The FMP has been through several addendums that have refined the harvest levels and allocation between states. Most recently addendum VII was approved in February 2012 (ASMFC 2012). This addendum implemented the Adaptive Resource Management (ARM) Framework for use during the 2013 fishing season and beyond. The framework considers the abundance levels of

horseshoe crabs and shorebirds in determining the optimized harvest level for the Delaware Bay states of New Jersey, Delaware, Maryland and Virginia (east of the COLREGS).

In 2013 a stock assessment update was completed by the Horseshoe Crab Stock Assessment Subcommittee. It was a trend analysis and overfishing definitions were not defined because of data limitations. The analysis determined that there were regional specific trends in Atlantic Coastal Horseshoe Crab abundance. For the Delaware Bay region, which Maryland is associated with, there was evidence for demographic-specific increases in abundance through the time series of data, but trends have been largely stable since the 2009 stock assessment.

Summary

Horseshoe crab spawning varies by latitude but generally occurs between May and July along the Atlantic coast. An annual, localized spawning survey was initiated in 2002 to better determine spawning habitats and crab abundance. The Maryland Coastal Bays survey was initially set up to mirror the same time frame as the Delaware Bay horseshoe crab spawning surveys (May and June) to allow for comparisons. Spawning in the Maryland coastal bays typically peaks in June, and often continues throughout July. Since the noticeable temporal range of spawning is longer than this initial sampling period, the surveys have been extended into July since 2007. Twelve annual surveys, 2002-2013, have resulted in 700 documented observations and a sum total of 145,168 horseshoe crabs (Table 7.6.1).

Table 7.6.1 Summary of horseshoe crab counts over time.

Total # of Horseshoe Crabs counted by month and year					
YEAR	May	June	July	Aug	Grand Total
2002	0	105			105
2003	2	521			523
2004	57	632			689
2005	48	261			309
2006	125	3,793			3,918
2007	711	6,636	270		7,617
2008	1	4,689	5,928		10,618
2009	10	18,627	3,190	19	21,846
2010	1,205	17,285	4,948		23,438
2011	5	15,166	7,934		23,105
2012	2,032	13,330	5,748	17	21,127
2013	261	22,875	8,737		31,873
Grand Total	4,457	103,920	36,755	36	145,168

The majority of crabs, 119,080 (82%), were observed to be spawning at or within one meter of the high tide line. It was noted that during the highest spawning activity along Skimmer Island that a substantial number of the crabs were spawning 2 or more meters out along the shoreline. These results only reflect those estimates for 1m² of the high tide line to be consistent in

surveying methodology, and therefore the estimates of total crabs on the beach during high density spawning are lower than actually observed.

The survey counts over the dozen years indicate a gradual increase in male to female ratios particularly in 2006 and 2009, and have remained relatively stable (Table 7.6.2). In 2013, we found 3.6 males to every female crab. This is important for maintaining genetic diversity. Harvest regulations in Delaware Bay, Maryland and Virginia have capped the number of female horseshoe crabs that can be harvested. This data indicates that male biased harvest in recent years has not had an effect on the local spawning population's ratio.

Table 7.6.2 Total number of male and female horseshoe crabs and sex ratio by year.

	Males (M)	Females (F)	M:F ratio
2002	67	38	1.8:1
2003	314	209	1.5:1
2004	438	251	1.8:1
2005	182	127	1.4:1
2006	2,939	979	3.0:1
2007	5,799	1,818	3.2:1
2008	8,289	2,329	3.6:1
2009	17,551	4,295	4.1:1
2010	18,642	4,796	3.9:1
2011	18,508	4,597	4.0:1
2012	16,872	4,255	4.0:1
2013	24,876	6,997	3.6:1

References

- Atlantic States Marine Fisheries Commission (ASMFC). 1998a. Interstate Fishery Management Plan for Horseshoe Crab. Fishery Management Report No. 32 of the Atlantic States Marine Fisheries Commission. Washington D.C. 58pp.
- Atlantic States Marine Fisheries Commission (ASMFC). 2012. Addendum VII to the Fishery Management Plan for Horseshoe Crab. Fishery Management Report No. 32g of the Atlantic States Marine Fisheries Commission. Washington D.C. 10pp.
- Atlantic States Marine Fisheries Commission (ASMFC). 2013. Horseshoe Crab Stock Assessment Update. Report of the Horseshoe Crab Stock Assessment Subcommittee. Management Report of the Atlantic States Marine Fisheries Commission. Washington D.C.
- Botton, M.L. and R.E. Loveland. 1989. Reproductive risk: high mortality associated spawning by horseshoe crabs (*Limulus polyphemus*) in Delaware Bay, USA. *Marine Biology* 45(3): 637-647
- Botton, M.L., R.E. Loveland and T.R. Jacobsen 1994. Site selection by migratory shorebirds in Delaware Bay, and its relationship to beach characteristics and abundance of horseshoe crab (*Limulus polyphemus*) eggs. *Auk* 111(3): 605-616
- Loveland, R.E., M.L. Botton and C.N. Schuster, Jr. 1996. Life history of the American Horseshoe crab (*Limulus polyphemus* L.) in Delaware Bay and its importance as a commercial resource. In: Farrell, J and C, Martin (eds), Proc. Horseshoe Crab Forum: Status of the Resource. University of Delaware, Sea Grant College Program. 60 pp
- Schuster, C.N., Jr. 1950. Observations on the natural history of the American horseshoe crab, *Limulus polyphemus*. 3rd. report. Investigations of Methods of Improving the Shellfish Resources of Massachusetts, Woods Hole Oceanographic Inst. Contrib. No. 564:18-23
- Schuster, C.N., Jr. and M.L. Botton. 1985. A contribution to the population biology of horseshoe crabs, *Limulus polyphemus* (L.) in Delaware Bay. *Estuaries* 8 (4): 363-372