Horseshoe Crab

Activity level: Medium

Committee Overlap Score: Low (SAS overlaps with BERP)

Committee Task List

- TC/SAS –Benchmark stock assessment
    - SAS Chair – May 2019: Present the stock assessment to the Board
- TC – March 1st: Annual compliance reports due
- ARM & TC – Fall: Annual ARM model to set Delaware Bay specifications, review red knot and VT trawl survey results

TC Members: Jeff Brunson (SC, TC Chair), Gregory Breese (USFWS), Joanna Burger (Rutgers), Ellen Cosby (PRFC), Claire Crowley (FL), Deb Pacileo (CT), Jeffrey Dobbs (NC), Steve Doctor (MD), Samantha Macquesten (NJ), Adam Kenyon (VA), Mike Millard (USFWS), Natalie Ameral (RI), Derek Perry (MA), Linda Stehlik (NMFS), Chris Wright (NMFS), Jordan Zimmerman (DE), Kristen Anstead (ASMFC), Michael Schmidtke (ASMFC)

SAS Members: John Sweka (USFWS, SAS Chair), Linda Barry (NJ), Jeffrey Dobbs (NC), Michael Kendrick (SC), Natalie Ameral (RI), David Smith (USGS), Richard Wong (DE), Kristen Anstead (ASMFC), Michael Schmidtke (ASMFC)

NEW JERSEY AUDUBON

23 April 2019

Comments: Draft 2019 Horseshoe Crab Benchmark Stock Assessment
Submitted by: Dr. David Mizrahi, Vice-president for Research and Monitoring, New Jersey Audubon Society

Dear Sir or Madam:

Thank you for providing the Draft 2019 Horseshoe Crab Benchmark Stock Assessment for review and comments. Given the public had only six days to review the 253-page assessment, I hope you will accept these comments despite their delivery after the 5 p.m.

As a shorebird ecologist working in Delaware Bay, and a member of the State of New Jersey's Endangered and Nongame Species Advisory Committee, I have a long-term professional interest in the results of this Assessment. Upon my rapid review of the 2019 Benchmark Assessment, I was disappointed to find several significant deficiencies, which I describe below.

1) ASFMC apparently did not conduct a detailed analysis of biomedical mortality or its impact on the Delaware Bay spawning population generally, and specifically female crabs which produce eggs for red knots (federal threatened) and other shorebird migrants.
    a) The Stock Assessment Subcommittee (SAS) did not appear to use available, facility-specific biomedical data (per ASFMC 2004, Addendum III, pg. 4-6) to perform a detailed assessment of biomedical mortality for Delaware Bay or other spawning populations. The SAS apparently reviewed extant biomedical mortality studies from literature, reviewed in previous stock assessments, and re-adopted the current estimate of 15 percent post-bleeding mortality. This approach brushes by the potential to identify specific areas where improvement in biomedical best management practices could be implemented to reduce crab mortality and improve crab conservation efforts.
    b) This approach also did not appear to account for the potential sale of Delaware Bay bait crabs, for bleeding and bait use, outside the Mid-Atlantic region (e.g., sale of Delaware bait crabs to Massachusetts, see below).

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c) Biomedical data, used in Assessment models and analyses, were redacted rendering analyses, results and conclusions unavailable to scientific or public review. This is counter to normal scientific peer-review processes.

2) The lack of female crab recovery was not apparently addressed in the Assessment in the context of available long-term population data (Atlantic Coast Benthic Trawl Survey, Hata and Hallerman 2018) and the long history of ASFMC harvest reductions focused on increasing female crabs.

a) Catch-per-tow and population estimates from the Benthic Trawl indicate immature females (~8 years old) are equal or twice as abundant as immature males, and the population size of Immatures is roughly equal to "mature" crabs.

b) Despite the high number of immature females, ready to recruit to mature age classes in 2-3 years, the abundances of females in "newly mature" and "mature" age classes were much lower than males, ranging from 0.33 to 2.0 times lower than "newly mature" males and 2 to 3.5 times lower than "mature" males, respectively. This is clearly due to unaccounted mortality of mature females and cannot be attributed to a lag in female recovery, egg or larval mortality.

c) In contrast, male crabs appear to be increasing, despite increased male harvest under the ARM Model, while females have failed to increase despite prohibition of female harvest under the ARM Model. The Assessment did not examine these contradictory trends in male and female age classes.

d) The Assessment did focus on modeling a "sustainable female harvest" of over 600,000 crabs from a 5.4 million female population. This model suggests a theoretical population that is 2/3 the size of the current female population (>8 million) -- is sustainable when the current female population is not capable of producing sufficient eggs to support red knots.

e) The red knot population has not increased according to mark-resighting population estimates by the ARM Subcommittee.

f) Horseshoe crab egg densities remain at or below 8,000 eggs/m2 (A Dey, pers. comm.) an order of magnitude below densities observed in New Jersey in 1989-1991 prior to large bait harvests of the mid 1990s (Botton et al. 1994).

g) These problems are demonstrative of a management paradigm that favors short-term commodity production (bait and lysate) over rapid restoration of crabs, red knots and ecosystem function of Delaware Bay.

3) The Adaptive Resource Management (ARM) Model was implemented in 2013. Although the ARM Model management objective favored Maximum harvest rather than the rapid restoration of horseshoe crabs, the ARM was embraced as an improvement, and shorebird ecologists and conservation practitioners (federal, state and conservation organizations) agreed to support this effort with data and technical participation.

a) Despite the cessation of female harvest in NJ and DE (since 2006) and MD and VA (since 2013 via ARM), female horseshoe crabs have not increased since 2007 (Hata and Hallerman 2018). This trend is supported by lack of increase in horseshoe crab eggs for shorebirds and lack of increase in red knots.

We believe that bait harvest management alone, including ARM Model, has failed to increase female crabs, surface egg densities and red knot abundance. To be successful, management must account for all sources of crab mortality including those that are challenging to estimate.

Literature Cited:

ASFMC 2004. Addendum III to the Fishery Management Plan for Horseshoe Crab. Fishery Management Report No. 32c of the Atlantic States Marine Fisheries Commission. May 2004. 14 pgs.

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. The Auk 113(3):605-616.

Dey, A. Personal Communication, April 22, 2018. NJ Div. of Fish and Wildlife, Endangered and Nongame Species Program.

Hata, D. and E. Hallerman. 2018. Preliminary results of the 2017 Horseshoe Crab Trawl Survey. Report to the ASMFC Horseshoe Crab and Delaware Bay Ecosystem Technical Committees. Dept. of Fish and Wildlife Conservation, Virginia Polytechnic Inst. and State University, Blacksburg, VA.

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March 23, 2019
Mr. Chairman, Board Members and guests,

It has been an honor and privilege to work with the Commission and a remarkable group of marine resource managers and scientists for the past 28 years to conserve the Atlantic horseshoe crab, *Limulus polyphemus*. Upon my last day as a member of the Advisory Panel, I offer a tribute to the Commission and individuals who created the remarkable HSC Fishery Management Plan (FMP) with their initiative, vision, dedication and hard work.

While searching for horseshoe crabs for my new LAL firm in Charleston, I discovered that truck loads of crabs were being collected and transferred to Virginia for the bait market. After calling this matter to the attention of our SCDNR director, Robert Boyles, he led his staff and my wife in an effort to draft and find sponsors for a bill prohibiting out-of-state transport and for conserving this resource; the bill passed the SC Senate in 1991. Our bill became a model for conservation.

At the same time, biologists near Delaware Bay were responding to overharvesting for bait. The Univ. of Delaware sponsored a forum in February 1996 that drew 81 stakeholders for the first coordinated effort to address the crisis. The following issues were addressed by notable scientists and resource leaders:

- Carl Shuster discussed HSC exploitation and abundance;
- Robert Loveland and Mark Botton presented HSC life history and commercial use;
- Stu Michels addressed stock assessment;
- Tom O'Connell described Maryland's crab fishery;
- Pet Himchak described HSC resource monitoring and management in New Jersey;
- Benjie Swan discussed spawning survey activities; and
- Jim Cooper gave an overview of the new LAL industry.

Focused leadership was urgently needed to create an FMP. In response to harvest reduction measures in NJ and DE, MD State leadership expressed support for an Atlantic coast Interstate Fisheries Management Plan via ASMFC. The Commission lacked the staffing and financial resources at that time, so the MD Department of Natural Resources offered one of its Fisheries Service employees, Tom O'Connell, to serve as the Commission's Horseshoe Crab FMP Coordinator. ASMFC agreed, and Tom moved into this role with his salary covered by MD DNR.

Tom continued to serve for several years, coordinating the development and approval of the HSC FMP, Addendum 1 that established state-by-state harvest quotas and survey requirements. The FMP was accepted in October, 1998. Carrie Selberg took on Tom's duties at ASMFC in 2001. My recent interview with Tom provided the following details about the FMP development.

Plan Development Team (PDT): The success of the PDT that drafted the FMP and Addendums was due to the following individuals, who brought different skill sets to this team:

- Tom O'Connell, for his organization, interpersonal and planning/coordination skills;
- Eric Schrading (US FWS) for his biological knowledge and writing skills;
- Stew Michels (DE DNREC) and Peter Himchak (NJ Marine Fisheries Division) for their biological insight and technical knowledge of HSC and population surveys; and
- Paul Perra (NOAA NMFS) for his ASMFC experience and strong partner relations.

Technical and Stock Assessment Committees:

- Dr. Dave Smith, US Geological Survey, Leetown Science Center, for his survey design, statistical analysis and decision support skills. Dave was a lead author of the Adapative Resource Management framework for horseshoe crabs, and member of the HSC SAC;
- Dr. Jim Berkson (VA Tech Univ) for his ability to work with technical experts and limited data to design a horseshoe crab stock assessment framework. At an early meeting at VA Tech, Jim was credited for laying out a vision of a framework to assess horseshoe crabs that was accepted and implemented by the SAC;
- Dr. Mike Millard (US FWS) for his leadership and technical skills; and
- Carl Shuster, Benjie Swan, Stew Michels, Pete HImchak, Joanna Burger, Mark Botton, Robert Loveland and many other state biologists for their early technical contributions.
- (Stock Assessment Report No. 98-01 was published February 1999.)

Advisory Panel:

- Dr. Jim Cooper and Robert Munson for co-chairing the AP and working with a very diverse group of stakeholders, and for representing their views even when in disagreement.

Tribute is also paid to Roy Miller who skillfully chaired the Horseshoe Crab Board during the contentious early period of development and implementation of the FMP, when watermen and environmentalist vigorously argued their positions. Roy recently said that the biggest disappointment of his era was failure to find a suitable bait alternative, a view we all share.

A personal tribute is also paid to Robert Boyles, SCDNR Director, who exemplified how industry and marine resource managers can work together for the best use of public resources. Robert always had a skillful and cheerful way to manage the most challenging problems. Thank you, Robert.

As indicated by the recent Stock Benchmark Assessment, the implementation of the FMP, the prudent use and conservation practices of the LAL industry and the continued work of marine scientists has secured the sustainability of the Atlantic horseshoe crab.

Finally, as your LAL resource, I have some comments about the future of LAL. The Chinese horseshoe crab is threatened because of habitat loss, overfishing for human consumption, and production of TAL (*Tachypleus* amebocyte lysate). In the absence of a return-to-sea policy, TAL crabs subject to 100% mortality, a vivid reminder that a similar fate could have befallen our horseshoe crab without the protection of LAL practices in the US. Cooper and Levin applied a return policy for LAL production from the outset of our biomedical-use discovery in 1970. TAL firms produce about 15% of the amebocyte lysate global market. They will turn to using LAL as their crab population is exhausted. Some TAL firms will purchase LAL directly from US firms while others may attempt to establish bleeding facilities in the US; ASMFC member states need to anticipate their response to this possibility.

Mortality does not occur during the LAL-related bleeding process of donor crabs, which is analogous to human blood donation. Rudloe (1983) studied the impact of bleeding on a large number of crabs in a Florida bay and estimated that bleeding increased the risk mortality by

about 10%. The SAS considers this number trivial in comparison to other HSC threats. Only older HSC, which have thinning shells and are heavily laden with a vast array of parasites and other organisms, are susceptible to the stress conditions of bleeding. The tagged crab found at Moore's Beach, NJ, is evidence that bleeding does not discourage spawning activity. (Photo from Benjie Swan.

In closing, I express my sincere appreciation for the opportunity to participate in Commission activities that conserve our horseshoe crab. It has been a truly rewarding experience. I consider it 28 years well spent!

Respectfully submitted,

James F Cooper, PharmD

Bled horseshoe crab tagged June 21,2018 and released in a creek a little to the south of Moore's Beach and found spawning July 1, 2018 on Moore's Beach.