

Date: 6/1/2023

To: Michael Nelson, Ph.D., MA Natural Heritage & Endangered Species Program

From: John Sweka, Ph.D., U.S. Fish & Wildlife Service

RE: Proposal to list horseshoe crabs as a MA Species of Special Concern

I have reviewed the proposal by Sharl Heller (Southeastern Massachusetts Pine Barrens Alliance) to list horseshoe crabs as a species of Special Concern in the Commonwealth of Massachusetts. The justification of the proposal to list the species stems from a perceived decline in abundance, reported disappearance from spawning beaches, inadequate past management, and importance of crabs as food for other species (e.g., shorebirds).

During my review, I identified several instances where statements made by the proposer were factually incorrect, misleading, or lacking context. Below, I detail these instances and provide counter arguments and additional context. I also attach a version of the proposal with my specific comments indicated on the \*.pdf of the proposal. At the end of my review, I provide several citations that I can supply copies of if you do not already have them.

#### **SPECIFIC COMMENTS:**

**Page 7: *"In Delaware Bay, horseshoe crab regulations have not been tight enough to bring back the horseshoe crabs and the density of their eggs has not increased (Smith et al., 2022)."***

The density of crab eggs in DE Bay has increased during recent times and in a similar manner to an increase in observed in crab abundance. Smith et al. (2022) compared recent egg density estimates to those presented in Botton et al. (1994) to conclude that egg densities have not increased. This direct comparison is erroneous due to differences in sampling design and egg processing techniques. Further details as to why this comparison is not appropriate are given in ASMFC (2022a) as part of a response to minority reports on the Adaptive Resource Management model for the Delaware Bay population of crabs.

**Pages 8 – 9: *Trends in female/male horseshoe crab ratios a sign of continuing horseshoe crab decline.***

It should be noted that the sex ratio of adult horseshoe crabs will naturally be skewed because male crabs mature at younger ages than females (Smith et al. 2009). Also, the sex ratio on the beach is not indicative of the sex ratio in the overall population because males will attempt to spawn more frequently than females within a spawning season (Smith et al. 2010). In the Delaware Bay system, the sex ratio actually became more skewed toward males following a moratorium on female harvest (ASMFC 2019) yet both sexes have increased in abundance (ASMFC 2022a). Thus, a sex ratio that favors males is not indicative of excessive harvest of females. It could be an indication of an increasing population (as in Delaware Bay for example) with adult male abundance increasing sooner than adult female abundance because of the sexual differences in the age at maturity.

**Page 9: *"The results documented a mortality rate of 30%, substantially higher than the 5-15% estimate currently used for management of this fishery (Leschan and Correia, 2010)."***

Leschen and Correia (2010) is but one of several studies that examined the effects of the biomedical process on crab mortality. As part of the most recent ASMFC (2019) stock assessment, a meta-analysis

was conducted to synthesize the results of several studies including Leschen and Correia (2020). That analysis showed average post-bleeding mortality was 15% with 95% confidence intervals of 4 - 30%. Thus, estimates of 30% are on the high end of the potential distribution of post-bleeding mortality. It should also be noted that long-term effects of bleeding on survival actually showed bled crabs survived at a higher rate than unbled crabs (Smith et al. 2020).

**Page 11: In reference to fishery independent surveys conducted in South Carolina, “Three trawl surveys, each made in the spring and fall, track horseshoe crab populations in South Carolina. The ASMFC stock assessment threw out some of those surveys because too few horseshoe crabs were caught in the towns to make the data remotely meaningful. The surveys that remained all demonstrated downward trends.”**

This statement is false. The remaining surveys that were used by ASMFC to determine stock status from the SC area showed stable or increasing trends in the previous 5 - 10 years (ASMFC 2019; Table 54) and the overall status in the southeast region was considered "Good" by the stock status standards developed for the stock assessment and endorsed by an external peer-review panel of experts.

**Page 12: “Further, while lysate manufacturers claim the mortality of bled horseshoe crabs is low (a fisherman asserted at a recent horseshoe crab stakeholders meeting run by the Massachusetts Division of Marine Fisheries that only 1 or 2 percent died in the bleeding process), a study in South Carolina jointly run by the state and the bleeding company found that 20% of bled female horseshoe crabs died in the process.”**

The most recent fisheries management plan review for the 2021 fishing year (ASMFC 2022b) shows the coast wide mortality due to biomedical collection and bleeding. The 2010 to 2021 average mortality associated with the biomedical process (those that are observed dead plus an assumed 15% of those that are bled and released alive) is 15% and ranges from (14 - 18%).

**Page 12: “Despite that listing and the other regulations put in place, the population of crabs only stabilized at its depleted level, and after 20 years has not recovered (ASMFC stocks neutral in Delaware Bay).”**

The "neutral" designation was made relative to levels observed in 1998 when ASMFC first implemented a fisheries management plan for horseshoe crabs. The ASMFC (2019) stock assessment included data up through 2017 when the designation “neutral” stock status determination was made. Since then, more recent data has shown that the population has increased (ASMFC 2022a) and if the same criteria were used to designate a stock status in 2022, it would have been considered "good".

**Page 12: “The horseshoe crab takes for bait and biomedical is still too high there, as evidenced by the Virginia Tech Horseshoe Crab Trawl Survey, the only dedicated horseshoe crab survey along the entire east coast, and one which measures trends in juvenile, newly mature, and mature horseshoe crabs. This survey, which has run since 2002, shows no statistically significant increase in the population of adult female horseshoe crabs, the population needed to restore this species (Hallerman and Jiao, 2022).”**

This statement is false. There is a statistically significant increasing trend in the data. Wong et al. (2022) state in their annual report on the Virginia Tech Trawl Survey, "Mean catch-per-tow of mature male and female horseshoe crabs in the coastal Delaware Bay area continue to be highly variable, with their highest points in 2021, showing a positive trend over the time series."

**Page 13: “Compared to the other Atlantic states described above, Massachusetts has the least restrictions on take.”**

This statement is false. ASMFC's quota for Massachusetts under the fisheries management plan is 330,377 crabs while the State of Massachusetts imposes a lower quota of 165,000 crabs. This state quota has not been exceeded in recent years and is lower than some of the other states' quotas (ASMFC 2022b; Table 1). For example, Maryland's state quota is 255,980 male crabs and Virginia's is 172,828 crabs of combined sexes.

**Page 13: “Grady and Valiela (2006) proposed that horseshoe crab populations were most vulnerable when individuals were taken prior to sexual maturity, and that the population growth rate is most sensitive to the survival of older juveniles: likely the very horseshoe crabs that are collected during offshore bait take.”**

Sweka et al (2007) showed the population of crabs was most sensitive to age 0 survival and small changes in age 0 survival would have large effects on the future population.

**Page 13 - 14: “In a recent memo (McKiernan, 2023) to the Massachusetts Marine Fisheries Advisory, Proposal to Adjust Commercial Horseshoe Crab Limits for 2023, the DMF reported that in 2022, the biomedical horseshoe crab landings in Massachusetts approached 175,000 crabs. The DMF proposes to cap the 2023 biomedical take at 200,000. This is higher than the biomedical take in South Carolina where there is no bait take.”**

How is it known that biomedical crab landings in Massachusetts are higher than the biomedical take in South Carolina because South Carolina data are confidential (also because of the "Rule of Three")? ASMFC only reports total, coast wide biomedical take of crabs.

**Page 14: “However, the mortality of horseshoe crabs after up to 40% of their blood is removed and their subsequent handling and transport, is estimated to be 15-30%.”**

Again, ASMFC (2019) estimated the average mortality rate at 15% (95% confidence intervals of 4 - 30%).

**Page 14: “As noted earlier, it is difficult to make management decisions about takes without a population baseline or a clear indication of the sustainability of the takes. The collective data depict a population that has not recovered after changes in management practices (lunar closures, catch limits, etc.) put in place by the DMF.”**

These are contradictory statements. The first sentence argues there are no data to form a population baseline, but then the second sentence states that the population has not recovered after changes in management practices. What does recovery look like if we do not know what we are recovering to? Also, the argument that there is no baseline for comparison is overstated. The MA DMF trawl survey extends back in time to 1978 – a time period prior to the high horseshoe crab bait harvest of the 1990s.

**Page 14 – 15: “The ASMFC has determined that too few horseshoe crabs are caught to make these distinctions meaningful. However, without them, the only way of assessing trends in spawning females is spawning surveys on the beaches. 1) Those surveys did not begin until the population was depleted, so there is no baseline, and 2) the confidence intervals are so close in most of the surveys, that it is impossible to detect any real trends in the population overall, and 3) there are so few crabs caught in these surveys that according to the ASMFC stock assessment analysis, it's impossible to**

***detect trends in the overall population of female horseshoe crabs, let alone trends in mature females. In summary, there is no indication that the population is rebounding.”***

The MA DMF trawl surveys have collected crab data since 1978 and a time period from 1978 - 2017 was used in the ASMFC (2019) stock assessment, so it is not true that surveys began after the stock was possibly depleted during the high coastwide harvest of the 1990s. Although it is true that the statistical power of the MA DMF Trawl surveys is low because of high variation on annual indices of abundance, this does not mean that they cannot determine trends if those trends are large enough. South of Cape Cod, the MA DMF Trawl Survey showed an increasing trend over the last 10 years used in the ASMFC (2019) stock assessment. Also, results of autoregressive integrated moving average models (ARIMA) fit to MA DMF Trawl indices of abundance showed a low probability of those indices being less than levels in 1998 when ASMFC management was enacted. There was also a low probability of being less than a 25th percentile index based reference point, which has been suggested as a fisheries management benchmark if other biological benchmarks do not exist (Helser and Hayes 1995). When looking at the 2021 MA DMF compliance report that was supplied as Appendix 4 of this proposal, Figures 2 – 5 of that report suggest an increase in horseshoe crabs both north and south of Cape Cod. These data are more recent than what was in the ASMFC (2019) stock assessment report and indicate the population that can withstand recent exploitation levels.

**Page 15: “Removal from the list will be predicated by populations returning to historical densities of spawning horseshoe crabs throughout its range in Massachusetts and the recovery of red knot and other shorebird populations dependent on horseshoe crab.”**

What are the historical densities? It is argued that a historic baseline for comparison does not exist, so it is difficult to define what the historic spawning densities were? Also, recovery of red knot depends on additional factors beyond the influence of horseshoe crabs on population dynamics. The declaration of red knot recovery under the ESA would mean the species is delisted because it is currently listed as a threatened species. Is the intent of the proposer to maintain horseshoe crabs as a Massachusetts species of Special Concern until red knots are removed from the federal Endangered Species list?

#### **Appendix 1**

The tables of Appendix 1 report densities of spawning horseshoe crabs as general categories (e.g., "high", "moderate", "reported") for 2007. There is no context for what these categories represent in terms of quantitative metrics and there is no context without a time series of densities for which to conclude if they have increased or decreased.

#### **Appendix 5**

Appendix 5 seems to report spawning densities of crabs, but there is no text to accompany the graphs. From these graphs, there does not appear to be a declining trend in spawner density and if anything, it appears to have increased in the most recent years for some areas. Those beaches with longer time series of data tend to show their lowest densities of spawning crabs in the early 2010s with an increase in the most recent years (2018 – 2022). It would be nice to see some formal trend analyses of these data, but my general observation is very similar to what has been seen in data from the Delaware Bay area – lowest observed abundance around 2010 followed by increasing abundance in more recent years (ASMFC 2022a). This type of temporal variation should be expected for a long-lived species with a late age at maturity following a period of high exploitation. Commercial bait landings were highest in the late 1990s and given the time to maturity (9 – 10 years), the lowest abundance of crabs would be expected to be seen approximately 10 years later, followed by an increase due to reduced harvest in the early to mid 2000s. These population dynamics are also seen in Appendix 4 of the proposal (MA DMF

2021 compliance report to ASMFC). Indices of abundance from the spring MA DMF trawl survey are lowest around 2010 and increase thereafter.

## **Appendix 6**

The meta-analysis of trends conducted by the IUCN clearly shows evidence for some declines in horseshoe crab abundance along the Atlantic coast, and consensus among the various surveys for declines in the New England region. However, 2011 or 2012 was the terminal year in the survey data examined by that meta-analysis. Given the length of time that has passed since these data were analyzed, it is questionable if the conclusions drawn in 2012 can adequately describe the status of horseshoe crabs today.

### **CONCLUSIONS:**

I agree with the proposer on the importance of horseshoe crabs to a functioning nearshore marine ecosystem and that this importance has been ignored until relatively recently (e.g., there was no fisheries management plan for horseshoe crabs prior to 1998). I also agree with the proposer that there is insufficient data for horseshoe crabs in Massachusetts to fully understand the population dynamics of the species in this area and to provide estimates of population size through time. The longest time series of abundance indices comes from the MA DMF trawl survey, which is not designed to efficiently capture horseshoe crabs and does not sex or categorize crabs according to life stage. Ideally, there would be a trawl survey designed for Massachusetts waters that is similar to the Virginia Tech trawl survey conducted in the Delaware Bay region. However, the data that do exist are still useful and have been endorsed for use by ASMFC in numerous stock assessments as well as by the IUCN in their assessment of horseshoe crabs.

From the data presented in the proposal to list horseshoe crabs as a species of Special Concern in Massachusetts, I cannot conclude that the species is currently declining in abundance. To the contrary, data in the proposal appendices point to evidence that abundance is increasing. The MA DMF trawl south of Cape Cod showed an increasing trend over its last 10 years of data used in the 2019 ASMFC stock assessment (2008 – 2017). This increasing trend appears to be continuing given the survey's results presented in the MA DMF 2021 ASMFC compliance report (Appendix 4 of the proposal to list). The spring survey shows both males and female abundance are at all-time highs – even higher than abundance indices observed prior to the high coast-wide harvest period that occurred in the late 1990s. It also appears that abundance has more recently increased in the Gulf of Maine, north of Cape Cod. Spawning beach surveys are limited both spatially and temporally, but spawning densities presented in Appendix 5 show recent increases for several beaches over low points in the early 2010s.

As per the “Listing Endangered Species in Massachusetts” document, a Species of Special Concern is “...documented by biological research and inventory to have suffered a decline that could threaten the species if allowed to continue unchecked...” The proposer for listing horseshoe crabs as a Species of Special Concern stated, “The most serious immediate impact on the species comes from exploitation as the result of commercial taking...” The ASMFC Horseshoe Crab Fishery Management Plan was adopted in 1998 and commercial landings in Massachusetts peaked at 545,715 individuals in 1999 (ASMFC 2013). The ASMFC quota for Massachusetts is now 330,377 crabs while the state has a self-imposed quota of 165,000 crabs. From 2001 – 2021, landings in Massachusetts have averaged 120,296 individuals per year. This represents a 78% reduction from peak harvest in 1999. Given that I can see no evidence in the proposal that horseshoe crabs are currently declining in abundance in Massachusetts (they could be possibly increasing), and harvest has been greatly reduced from its peak, it is my opinion that the most

serious impact to horseshoe crabs noted by the proposer is in fact “checked” and horseshoe crabs do not warrant listing as a Species of Special Concern in Massachusetts at this time.

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