Atlantic States Marine Fisheries Commission

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MEMORANDUM

TO: **Horseshoe Crab Management Board**

FROM: **Delaware Bay Ecosystem Technical Committee and Adaptive Resource Management Subcommittee**

DATE: **October 26, 2026**

RE: **2025 Survey Results, Recommendations for ARM Revisions, and 2027 Delaware Bay Horseshoe Crab Harvest**

The Delaware Bay Ecosystem Technical Committee (DBETC) and Adaptive Resource Management (ARM) Subcommittee (henceforth, the Committees) met jointly on October 5, 2026 to 1) review recent survey data for horseshoe crabs and red knots, 2) review bait harvest specifications for 2027 and make recommendations as necessary, 3) discuss a correction to an error found in the ARM model code, and 4) review modeling updates to the Utility, Reward, and Harvest Policy (URH) functions of the ARM Framework based on the input provided through the stakeholder engagement process conducted earlier this year. The discussions and recommendations of the Committees are summarized in that order below.

1. Review of Annual Survey Data for Horseshoe Crab and Red Knot

Andre Lai (Virginia Tech) presented the results of the 2025 horseshoe crab trawl survey (Lai et al. 2026). The Virginia Tech Trawl survey is designed specifically to characterize the horseshoe crab population in the coastal Delaware Bay Area (DBA) and Lower Delaware Bay (LDB) and has been conducted since 2002. It provides one of the main indices of horseshoe crab abundance used in the ARM Framework. The DBA was previously sampled from 2002 to 2011, and again from 2016 onwards. The LDB was previously sampled from 2010 to 2012, 2016 to 2021, and sampling resumed in 2025.

In the 2025 survey of the DBA, mean catches-per-tow of mature males and females declined from their 2024 levels and are consistent with the mean CPUE recorded in earlier years. Mean catches-per-tow of immature males and females have remained relatively stable since 2016. Mean catch-per-tow of newly mature males decreased from 2024, continuing to decline from their high values in 2021 and 2022 but remaining relatively consistent with CPUE values recorded prior to 2016. Following the revision of the sampling protocol to probe more ambiguous females for eggs, mean catch-per-tow of newly mature females continued to rebound from extremely low values since 2019, reaching their highest recorded value in 2025. There is a decreasing trend in mean prosomal width for mature and newly mature males and females. Based on the 2025 survey, population estimates for the DBA increased significantly for

both immature females and males compared to 2024. The estimated populations decreased from their 2024 values for mature crabs of both sexes, and newly mature males. The estimated population total for newly mature females increased from 2024 values.

In the LDB in 2025, there was an observed increase in stratified mean catch-per-tow for all demographic groups when compared to 2021. Similarly, the population estimates across demographic groups increased compared to 2021.

Jordan Zimmerman (DNREC) presented the results of the 2025 Delaware 30-foot Trawl Survey and Delaware Bay Spawning Survey. In 2025 for the index months of April-July, the geometric mean catch per nautical mile in the trawl survey decreased from 2024 and was slightly below the time series mean (Figure 1). When considering all months (March-December) the index is similar to 2023 and 2024 levels (Figure 2).

In the 2025 Delaware Bay Spawning Survey, sampling was conducted between May 10 and June 27 during 12 nighttime high tides, at 12 beaches in Delaware and 10 in New Jersey. Peak spawning in Delaware occurred May 10-14, and peak spawning in New Jersey occurred June 9-13. The bay-wide index of female spawning activity shows a slightly positive but not significant trend over the time series (1999-2025), while the index of male spawning activity shows a significant increasing trend (Figure 3). The male:female spawning ratio in 2025 was 5:1.

Dani Dyson (NJDEP) shared an update on the NJ Ocean Trawl Survey and noted that there is no data for 2025 due to vessel issues.

Jim Lyons (USGS) presented the results of the 2026 red knot surveys and stopover population estimate (Lyons 2026). The 2026 passage population of red knots in the Delaware Bay was estimated using a Bayesian analysis of a mark–resight model which accounts for population turnover and imperfect detection. The 2026 passage population estimate was 39,534 individuals (95% credible interval: 36,740–42,922). This represents a change of approximately -27% compared to 2025 but is similar to 2022 and 2023 levels. Kat Christie (DNREC) presented additional information on the 2025 Delaware and New Jersey shorebird surveys, noting a recurring trend of the ground counts exceeding aerial counts.

2. Review 2027 Bait Harvest Specifications

Under Addendum VIII (ASMFC 2022b), the 2022 ARM Revision is used to annually produce bait harvest recommendations for male and female horseshoe crabs of Delaware Bay-origin based on the abundance of horseshoe crabs and red knots. In October 2025, the Horseshoe Crab Management Board chose to set male-only harvest specifications of 500,000 males for two years (2026 and 2027) as allowed by Addendum IX (ASMFC 2025). Under Addendum IX, in interim years of multi-year specifications the male-only harvest limit is based on the male:female sex ratio of spawning horseshoe crabs on beaches observed in the bay-wide spawning survey. If the sex ratio is greater than or equal to 3:1, the maximum harvest of 500,000 Delaware Bay origin males is permitted. If the sex ratio is between 3:1 and 2:1, the

maximum allowable male harvest is reduced as the ratio decreases and would be zero if the sex ratio were to decrease to 2:1 or less.

The observed sex ratio in the 2025 bay-wide spawning survey was 5 males to 1 female, so the maximum harvest of 500,000 Delaware Bay origin males is permitted. Thus, the Committees recommend maintaining the 2027 harvest specifications. The allocations implemented for 2026 and 2027 are shown in Table 1.

Table 1. Delaware Bay-origin and total horseshoe crab quota for 2026 and 2027 by state with no female harvest and the 2-to-1 offset. Virginia total quota only refers to the amount that can be harvested east of the COLREGS line

State	Delaware Bay-Origin Quota		Total Quota	
	Male	Female	Male	Female
Delaware	173,014	-	173,014	-
New Jersey	173,014	-	173,014	-
Maryland	132,865	-	255,980	-
Virginia	21,107	-	81,331	-
TOTAL	500,000	0	683,339	0

3. Discuss Correction to ARM Model Code Error

Bryan Nuse (Bird Conservancy of the Rockies) was contracted to develop revisions to the URH functions in the ARM Framework model based on the 2026 stakeholder process input. In the process of this work, an error was identified in the 2021 ARM model code: rather than using annual bait harvest values alone to calculate annual reward when solving for optimal harvest policy parameters, total anthropogenic horseshoe crab mortality (bait harvest, bycatch, and estimated biomedical mortality combined) was used to calculate annual reward. This error ultimately resulted in a reward function different than what was intended by both the modelers and stakeholder groups.

Bryan presented a comparison of simulation results from each of the changes made to the 2021 ARM model, including the error correction. When comparing the results of the corrected 2021 model to the uncorrected 2021 model, the following differences are observed:

- The harvest policy function for male horseshoe crabs is very similar between corrected and uncorrected versions, with a slightly steeper slope in the corrected version. No change is predicted in male harvest levels over the long-term (100-year simulation).
- The harvest policy function for female horseshoe crabs in the corrected version is more likely to recommend female harvest levels closer to the cap, resulting in more predicted female harvest in the long-term.
- The harvest policy for females in the corrected version is more responsive to extremely low abundances of female crabs and comes closer to intersecting 0 at extreme low abundances, but it does increase rapidly as abundance increases.

- The corrected version has a very small effect on the long-term trajectories of red knot and female horseshoe crab abundance, with minor decreases in each (changes of -0.5% and -1.3%, respectively, over a 100-year time horizon).

The Committees acknowledged the need to correct the model code to the intended peer-reviewed methods so that reward is calculated based on bait harvest values only.

4. Review Updates to RUH Functions in the ARM Model

Bryan Nuse presented the revisions to the URH functions in the ARM Framework model. The revisions included the incorporation of three recommendations from the 2026 stakeholder engagement process (Compass 2026):

1. update HSC utility using a female-to male value ratio of 2.65:1.
2. update REKN utility to replace the current curve with the median curve from stakeholder-elicited values from the 2026 workshop.
3. implement a 7,000,000 threshold in female HSC harvest policy function, below which female harvest is 0.

Bryan Nuse implemented these recommendations through revisions to the 2021 ARM Framework model code and reran the model to produce solutions that were compared to the 2021 model solutions. When comparing the results of all three 2026 recommended revisions to the results of the corrected 2021 model, the following differences are observed:

- The predicted long-term trajectory of red knot abundance increases slightly, by 1.3%.
- The long-term trajectory of female horseshoe crab abundance increases by 4.2%.
- There is a 44.3% decrease in predicted female harvest over the long-term, which is influenced by the 7 million abundance threshold for when female harvest would be permitted.

The Committees recommend that the Board consider these model updates for future management. They noted some concern about the threshold creating instability in the female harvest recommendations because the results predict fairly frequent changes between a female harvest recommendation of zero and near the maximum of 210,000 females. However, it was noted that these simulations use data through 2021 only, and the female population estimate has increased since then. Therefore, it is likely that once more recent years of data are incorporated in the next update of the model parameters in 2027, the model will predict fewer switches between zero and a higher female harvest recommendation. The Committees also recommended that the stakeholder group be provided an opportunity to review the results of the model updates.

References

ASMFC. 2022a. 2021 Revision to the Adaptive Resource Management Framework and Peer Review Report. Arlington, VA.

ASMFC. 2022b. Addendum VIII to the Interstate Fishery Management Plan for Horseshoe Crabs. Arlington, VA.

ASMFC. 2025. Addendum IX to the Fishery Management Plan for Horseshoe Crab. Arlington, VA.

Compass Resource Management Ltd. 2026. Delaware Bay Horseshoe Crab Adaptive Resource Management Framework Stakeholder Engagement Final Report.

Lai, A., Jiao, Y., and F. Ferretti. 2026. Results of the 2025 Horseshoe Crab Trawl Survey: Report to the Atlantic States Marine Fisheries Commission Horseshoe Crab and Delaware Bay Ecology Technical Committees.

Lyons, J. E. 2026. Stopover Population Estimate and Migration Ecology of Red Knots *C. c. rufa* at Delaware Bay, USA, 2026. Memorandum to the Delaware Bay ARM Working Group, Laurel, Maryland.

Figures

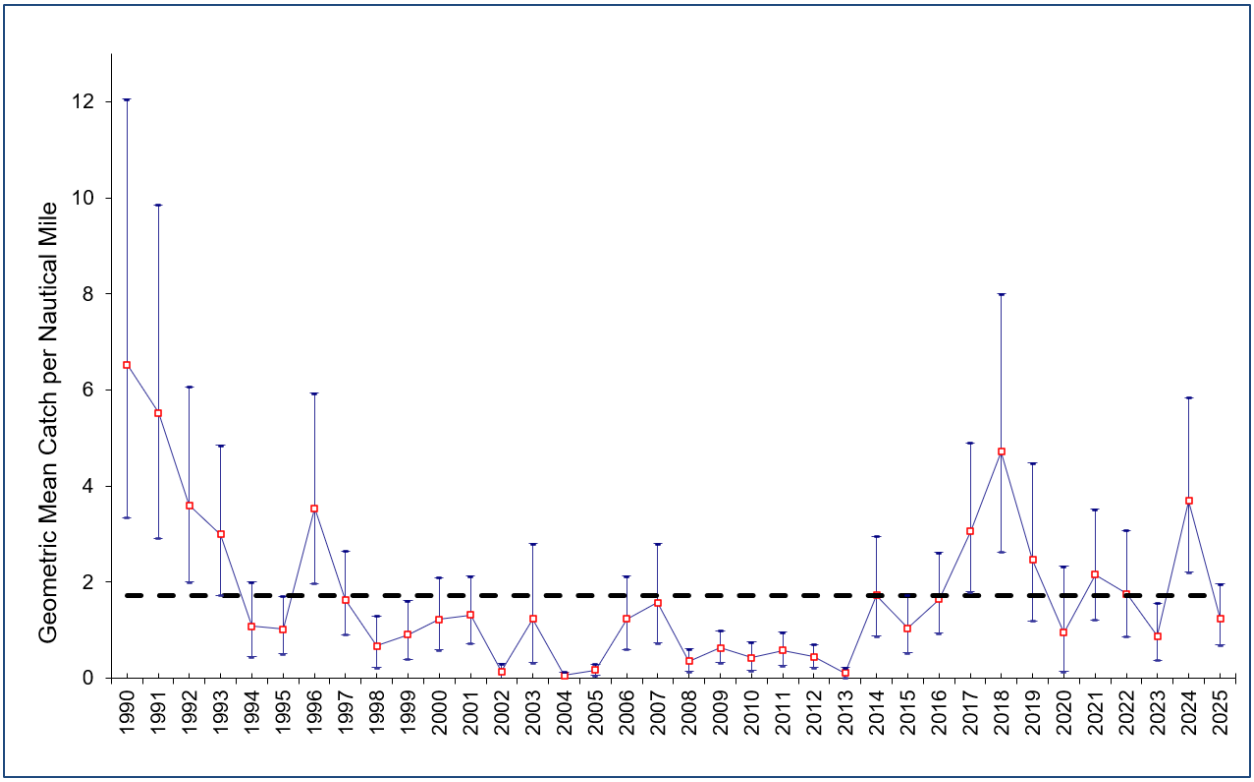


Figure 1. Adult horseshoe crab index from the Delaware 30-foot trawl survey for the months of April-July, 1990-2025.

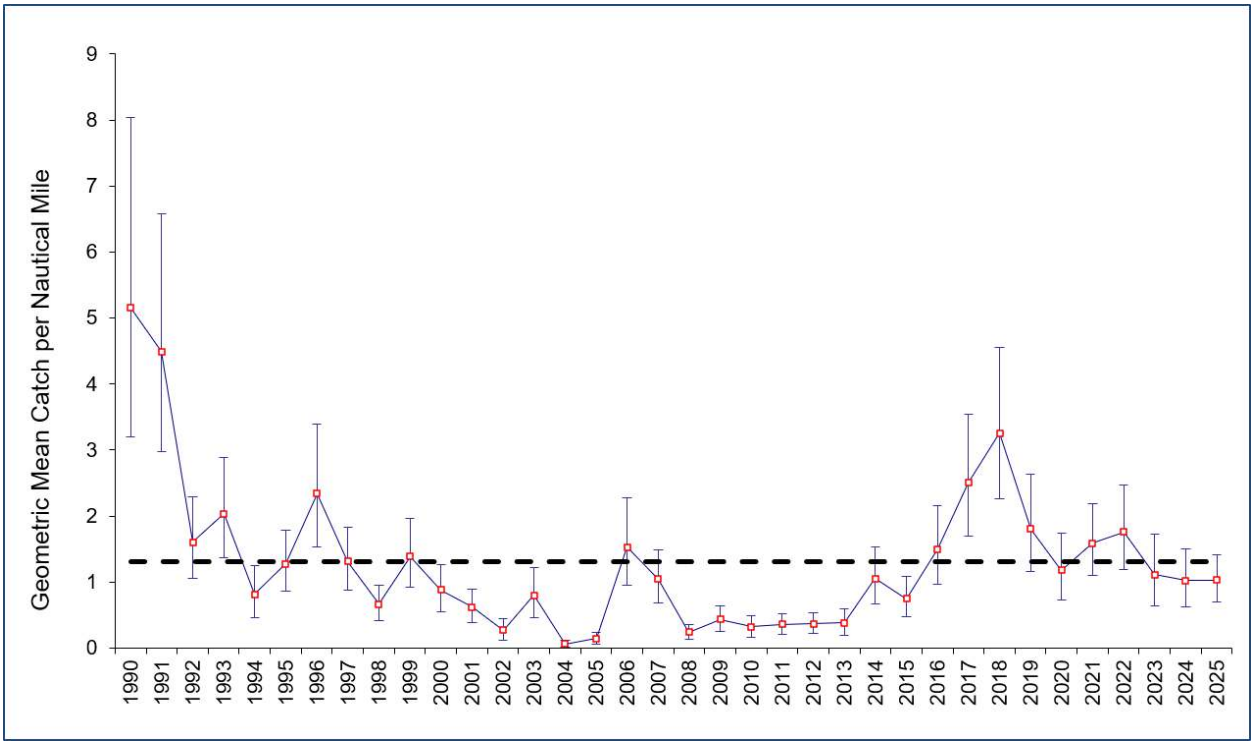


Figure 2. Adult horseshoe crab mean catch per nautical mile in the Delaware 30-foot trawl survey index for all months of (March-December), 1990-2025.

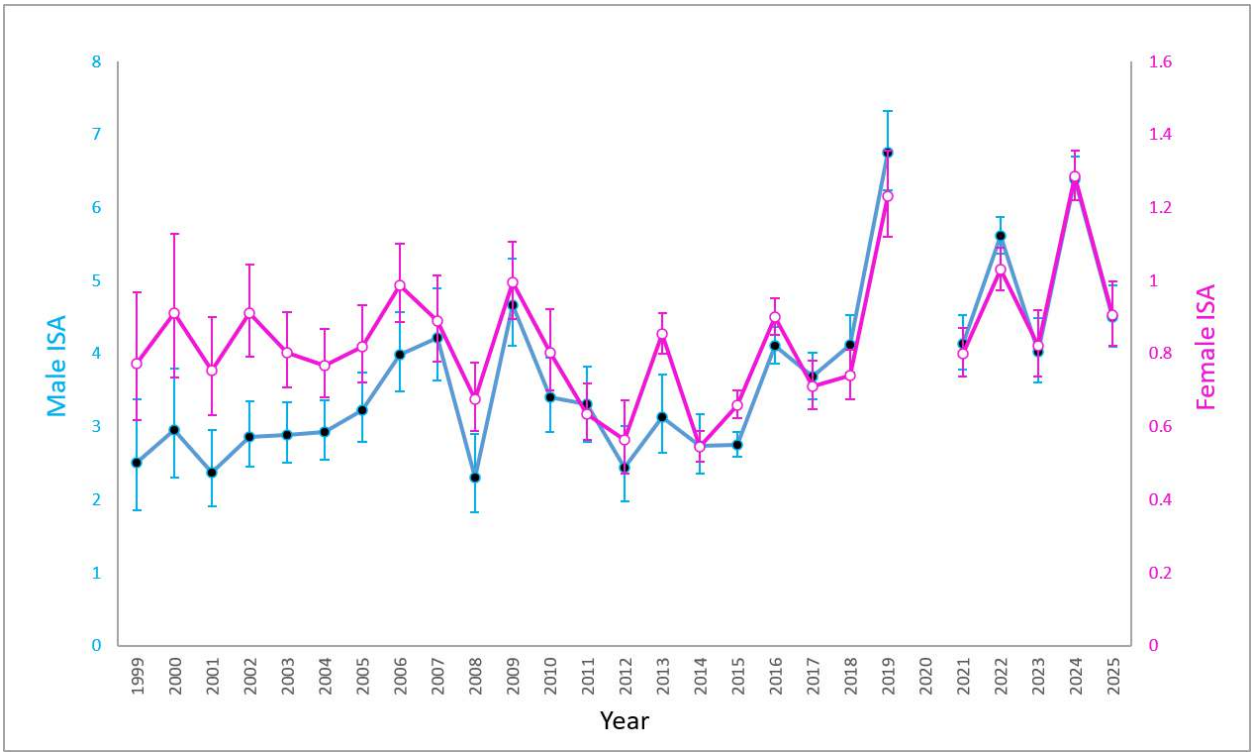


Figure 3. Index of horseshoe crab spawning activity for males and females from the Delaware Bay horseshoe crab spawning survey (baywide), 1999-2025.