



# Atlantic States Marine Fisheries Commission

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## MEMORANDUM

**TO:** Horseshoe Crab Management Board  
**FROM:** Adaptive Resource Management Subcommittee  
**DATE:** April 18, 2025  
**RE:** Recommendations for Reviewing Reward, Utility, and Harvest Policy Functions of the ARM Framework

### Background

In October 2024, the Horseshoe Crab Management Board (Board) reviewed the final report from the July 2024 [Stakeholder Workshop on Delaware Bay Management Objectives](#). The workshop convened a group of stakeholders representing environmental NGO, fishing, biomedical, bird and horseshoe crab scientists, and management perspectives to discuss the Adaptive Resource Management (ARM) Framework and management objectives for the Delaware Bay region bait fishery. Through a consensus-building process designed to surface core issues and concerns, gauge existing areas of common ground, and identify new areas of agreement, the workshop aimed to generate recommendations for Board consideration regarding horseshoe crab management in the Delaware Bay region.

One of the key recommendations produced was, “using current ASMFC processes, refine the ARM reward and utility functions with stakeholder input.” The Board supported this recommendation and tasked the ARM Subcommittee (Subcommittee) with reviewing the reward and utility functions of the ARM Framework and discussing what input from stakeholder groups would be needed to provide direction on changes. The ARM Subcommittee met three times in early 2025 to address this task and develop recommendations for next steps to address the workshop recommendation.

### Recommendations on Possible Changes to the Reward, Utility, and Harvest Policy Functions

The Utility, Reward, and Harvest Policy (U/R/H) Functions of the ARM Framework are the three functions within the ARM Framework that reflect values placed on horseshoe crabs (HSC) and red knots, and associate harvest levels with population abundance levels of both species. The utility functions for red knots and HSC were developed in 2021 by the Modeling Subcommittee based on their interpretation of earlier stakeholder input provided during development of the 2009 ARM Framework. These functions consider goals for each species that management is aiming to achieve. In the case of horseshoe crab harvest, maximum utility is achieved when the economic value of recommended harvest equals the economic value of the maximum allowable harvest of both sexes. For red knots, maximum utility is achieved when the population exceeds 81,900. The reward function reflects the combination of both horseshoe crab harvest and red knot abundance utilities and the objective is to maximize the total reward with the ideal

scenario for stakeholders being a red knot population above 81,900, and maximum HSC harvest allowed. The harvest policy functions establish how much HSC harvest would be allowed under different population abundance levels of red knots and horseshoe crabs.

The Subcommittee identified several aspects of these functions that could be modified to better reflect stakeholder values. These are summarized below.

**1. *Male and female relative harvest values in the horseshoe crab utility function***

The current HSC utility function assumes one female harvested is worth twice as much as one male harvested. These values could be changed if current values are different.

**2. *Maximum harvest levels (500,000 males, 210,000 females)***

The maximum possible harvest levels for males and females from the ARM Framework were negotiated and determined as acceptable to the industry during the original ARM Framework development process. It has been over ten years since these values were established and different maximum harvest limits may be more appropriate given current conditions.

**3. *The target and threshold abundance in the red knot utility function***

The target population of 81,900 red knots was based on estimates of historic red knot abundances observed in Delaware Bay. A new target could be developed based on a historical reference period and more available survey data. A proposal was submitted by the US Fish and Wildlife Service (USFWS) New Jersey Field Office for consideration by the ARM SC, which links red knot utility both to a more explicit historic reference value and to the 2023 USFWS red knot recovery plan.

**4. *Including population growth rate as a factor in the red knot utility function***

This would mean the reward value of red knots would depend on both population abundance and population growth rate. Growth rate could be derived from the red knot population model projections or the observed temporal change in annual mark-resight population estimates.

**5. *The slope and shape of the red knot utility function***

The Subcommittee noted that a more gradual increase could be explored, and that the shape of the curve could be altered to create a more sigmoid-shaped curve. The current curve results in an abrupt increase in utility after the threshold abundance with a straight slope up to the maximum utility level. A sigmoidal curve would allow changes in utility to occur more gradually when red knot the abundance is near the threshold or target. There was also discussion about conditioning red knot utility on the population size of red knots relative to the population size of horseshoe crabs to ensure that a growing population of red knots would continue to have adequate food supply.

**6. *Weights assigned to red knots and horseshoe crabs in the reward function***

The current function assigns equal reward value to red knots and HSC harvest. If it would better fit current stakeholder values, red knots and HSC could be assigned different reward value weights. Methods to determine appropriate weights of each term based on stakeholder values could be explored with experts in this type of exercise.

## **7. Harvest policy functions that intersect with zero**

This would result in the possibility of a zero-harvest output for either sex. The current harvest policy functions do not intersect with zero based on the adaptive management optimization process because population simulations never resulted in a situation where horseshoe crab abundance decreased to a level that would significantly impact red knot survival.

### **Recommended Process for Stakeholder Engagement**

The ARM Subcommittee discussed what type of process would be required to engage stakeholders in identifying and developing possible changes to the U/R/H functions. The group agreed that a series of meetings would be needed, including educational sessions, stakeholder meetings to elicit technical information to inform the U/R/H functions, and Subcommittee meetings to develop alternative U/R/H functions. The group emphasized the value of third-party facilitation to improve stakeholder buy-in and reduce the potential for bias. The Subcommittee recommends the Commission contract with a structured decision-making (SDM) expert to guide the development and execution of this process.

The Subcommittee proposes the following general process for conducting the review and revision of the U/R/H functions of the ARM Framework but notes that if an external SDM facilitator is contracted, they should be given the opportunity to design and structure the meetings as needed to achieve the goals of revising the U/R/H functions.

- **Step 1: Educational Meetings**

A series of educational sessions would be needed to increase the collective understanding of the U/R/H functions of the ARM Framework. These meetings could be conducted virtually, but they should allow for a dialogue between the technical experts on the Subcommittee and the stakeholders with an interest in providing input on the ARM Framework functions. Specifically, there should be dedicated question and answer sessions during these meetings to ensure stakeholders can gain the background knowledge needed to provide effective input. These meetings should focus on the technical functions of the ARM Framework and explain the differences between the 2009 and 2021 Frameworks. The ultimate purpose of these sessions (revising the ARM Framework U/R/H functions to better align with stakeholder values) and next steps in the process should be explained to attendees.

- **Step 2: Stakeholder Meetings**

A meeting or series of meetings should be convened with stakeholders representing different interest groups with the goal of eliciting information on values to inform revisions of the U/R/H functions. Stakeholders involved in these meetings should be provided with specific questions to elicit the necessary information. Particularly, the meetings should provide information on what conditions must be met for stakeholders to accept female horseshoe crab harvest, and how to phase it in. These meetings will require an SDM expert for designing and implementing a formal elicitation process.

- **Step 3: ARM SC and TC Meetings**

Once stakeholder input on the U/R/H functions is gathered, the Subcommittee will need a series of meetings to review the information provided by stakeholders and perform the technical work to develop alternative U/R/H functions that address their values. The Delaware Bay Ecosystem Technical Committee would also need to meet to review and approve any changes proposed by the ARM SC. These meetings could be conducted virtually.

- **Step 4: Board Meeting to Consider Proposed Changes to the U/R/H functions**

After alternative U/R/H functions are developed the Subcommittee would re-run the ARM model optimization and present proposed changes to the Board. If the Board wishes to pursue the recommendations at that time, it would need to initiate an Addendum to consider adopting any changes to the U/R/H functions.

### **Additional Considerations**

The Subcommittee noted a number of issues that should be carefully considered in the development of this process. The first is the level of engagement with a contracted SDM expert. The Subcommittee believes it would be most valuable for the consultant to be involved throughout the entire process, including the early educational sessions. This would allow them to gain a foundational understanding of the biology of the species, the ARM Framework, U/R/H functions, and stakeholders. However, it is absolutely critical for an SDM expert to guide the second step of stakeholder meetings.

Second, the Subcommittee noted that during the public comment period on Addendum VIII to adopt the 2021 ARM Revision, public opposition to the revised ARM Framework went beyond just the U/R/H functions. While the Subcommittee believes reviewing the U/R/H functions could help bring management more in line with stakeholder values, it warns there may still be objections to the outcome and underlying population dynamics models for each species.

Third, the Subcommittee emphasized the importance of thoughtful design regarding stakeholder participation. With a variety of stakeholder groups, it will be important to ensure different perspectives are heard and valued throughout this process. Some stakeholder groups are much larger than others, so it will be important to dedicate time to each group. At the same time, concerns have been expressed about limiting participation to too small a number, so it will be necessary to find the appropriate balance.

One member also raised concern about the differences in meeting accessibility for various stakeholders. Some stakeholders are more likely to be able to participate than others; for example, for some, workshop or meeting attendance is considered part of their job, but for others, attending a workshop precludes work. This concern could be partially addressed by offering stipends for meeting attendance. It would also be important to consider timing and geographic location of meetings. It can be especially difficult for those who work in the fishing industry to attend meetings during peak fishing seasons.