Atlantic States Marine Fisheries Commission

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Horseshoe Crab Adaptive Resource Management Subcommittee
Meeting Summary

September 11, 2019

Adaptive Resource Management Subcommittee Members: Jim Lyons (Chair, USGS), Lindy Barry (NJ), Jason Boucher (DE), Steve Doctor (MD), Larry Niles (CWF), Dave Smith (USGS), John Sweka (USFWS), Wendy Walsh (USFWS)

ASMFC Staff: Michael Schmidtke, Kristen Anstead

Public: Brett Hoffmeister (HSC AP Vice Chair, ACC), Nora Blair (Charles River), Joe Smith, Jordan Zimmerman (DE), Mike Millard (DBETC, USFWS), Amanda Dey (DBETC, NJ)

On the Phone: Greg Breese (DBETC Chair, USFWS)

The Adaptive Resource Management (ARM) Subcommittee (SC) met on September 11, 2019, in Arlington, Virginia. The meeting's goals were to define the value used for horseshoe crab abundance in the ARM Framework, discuss how to incorporate horseshoe crab population estimates from the Catch Multiple Survey Analysis (CMSA) model used in the 2019 benchmark stock assessment into the ARM Framework, discuss other potential revisions to the ARM Framework, compile a set of recommendations based on these discussions for consideration by the Delaware Bay Ecosystem Technical Committee (DBETC), and elect a new Chair and Vice Chair.

Following the comments by the peer review panel for the 2019 benchmark stock assessment for horseshoe crab, the Board tasked the ARM SC with considering the incorporation of population estimates for horseshoe crab in the Delaware Bay from the CMSA and the estimate of natural mortality into the ARM Framework since both values represent the best available data. Previously, the Board had tasked the ARM SC with accounting for biomedical mortality in the Framework, but tabled the proposed options until after the benchmark assessment.

The ARM SC discussed the definition of the current ARM Framework. Kristen Anstead presented aspects of the Framework that are not clearly defined in Addendum VII or previous ARM reports. One of these is the inclusion of primiparous crabs in annual adult abundance estimates from the Virginia Tech (VA Tech) Benthic Trawl Survey, which are used as an input to the ARM Framework. The ARM SC concluded that from a biological standpoint, primiparous crabs caught by the VA Tech Survey (conducted annually in the fall) would contribute to the number of eggs available to red knots the following spring and should be included in the adult population estimate. However, the ARM Framework currently does not account for mortality that occurs during the time lag between the VA Tech Survey and the red knot stopover. The ARM SC agreed that this should be accounted for moving forward by applying half of the annual total adult mortality rate estimated from the benchmark stock assessment (0.274) to primiparous and multiparous male and female crab abundance estimates from the VA Tech Survey. The ARM SC also determined that population estimates made using the swept area delta distribution are those that are and will be used as inputs for the ARM Framework.

John Sweka presented potential changes to the ARM Framework that would more directly connect it to the CMSA model and replace several of the current Framework's theoretical assumptions with empirical estimates. One of these changes is to estimate a spawner-recruit relationship for horseshoe crabs and use it to project the assessment's CMSA model into the future to estimate male, female, and total carrying capacities (K). This relationship would view primiparous crabs as recruits, thus estimating the number of primiparous crabs based on the number of spawners (multiparous and primiparous females) from 10 years (female age of maturity) earlier. Initially, due to limited data, a hockey-stick spawner-recruit model could be used. However, each additional year abundance data would provide an additional data point that could eventually lead to the use of a Ricker model, which is probably more representative of horseshoe crab reproductive biology and behavior. Use of the CMSA population estimates includes other changes to the ARM such as inclusion of bait harvest, discard, and biomedical mortality and improved estimates of natural mortality. Currently, the CMSA model is only applied to females due to convergence issues in fitting a model for males. However, further efforts to model males can be made, and they can be estimated and projected in the interim using sex ratio information. Sweka also suggested an update of red knot information used in the ARM model, including survival rates, mass gain, and model weighting.

The ARM SC discussed several aspects of the potential revisions. The SC noted that egg survival is likely more contingent on weather conditions during and shortly after spawning than the number of spawners. At the same time, the SC recognized that a certain number of spawners must be present to produce recruits. Limited data and poor fitting models are common for spawner-recruit relationships for many species, but the value of being able to project recruitment forward based on even this limited data has value for estimating population characteristics such as K. The model fit could also improve over time with data from additional years of all surveys in the CMSA and stage information now being collected by NJ and DE state surveys. Inclusion of actual removals information in the ARM model is an improvement, which can be made even better through improved estimates of discards and associated mortality. The SC discussed the possibility that use of this method could change K and influence harvest package selection. This could lead to the same, increased, or decreased bait harvest. However, the SC agreed that the proposed methodology is an improvement because it is more defensible. The SC recommended to move forward with using the CMSA model for estimation and projection as the underlying horseshoe crab population model in the ARM Framework. The SC also recommended reassessment of the ARM utility of female horseshoe crab harvest as a function of female abundance.

Dave Smith informed the ARM SC of a project that will be undertaken at the USGS Leetown Science Center to transfer the ARM Framework from its current software (ASDP) to MDPSolve, a software written in the more widely used MATLAB programming language. This project could incorporate the proposed ARM revisions. After completion, the model could be housed with the Commission and staff could be trained to run it.

The ARM SC discussed inclusion of biomedical data in the ARM Framework. Two methods for doing so had been discussed and tested in earlier meetings. However, through the use of the CMSA horseshoe crab population estimates, the ARM SC considers biomedical use of horseshoe crabs and associated mortality adequately accounted for.

The ARM SC discussed how to publicly present ARM information including population estimates and harvest package results, given the use of confidential information in CMSA abundance estimates. The ARM SC agreed that the ability to publish population estimates from the CMSA base run would be most accurate, and that the Commission should request permission to publish this estimate from the

biomedical companies. Given denials of past requests for this permission, the ARM SC also considered other options for presenting results if this request is not made by the Board or is denied by the companies.

The ARM SC considered use of a moving average of biomedical mortality over multiple years, as well as a simulation based on a moving average and standard deviation. Use of the coastwide biomedical mortality applied to the Delaware Bay region was also considered. While this would underestimate the population in the region it would produce a publicly viewable number that could be recognized as a lower bound. Given the small impact of biomedical use observed by the stock assessment, this conservative estimate still likely would not change harvest package selection. The ARM SC also discussed use of 0% biomedical mortality, which would also give a publicly viewable upper abundance estimate and likely the same harvest package as the CMSA base run. Use of either the coastwide or 0% biomedical mortality was not preferred because of known directional bias. Therefore, the ARM SC recommended that the ARM model be run with the CMSA using both the 0% biomedical mortality and the coastwide biomedical mortality attributed to the Delaware Bay region. Population estimates from both methods would be published as population bounds and the resulting harvest package, if the same, would be used in management. If the harvest package differed, the more conservative harvest package would be used in management. This recommendation was revised after further discussion with the DBETC.

The ARM SC discussed the definition of Delaware Bay-origin crabs and the current use of abundance estimates from the VA Tech Survey, given the survey's sampling area relative to stock structure and movement information used in the assessment. The ARM SC noted that crabs that spawn in Delaware Bay may also spawn in other areas, such as coastal bays of Maryland or Virginia, in other years. Tagging information shows movement and exchange among different parts of the Delaware Bay region. The ARM SC discussed coverage of the Delaware Bay region (considered from the Virginia-North Carolina state line through New Jersey). The VA Tech Survey does not cover the northernmost and southernmost extremes of this region, but does cover a large majority of the region. Also, the majority of horseshoe crabs observed in New Jersey's Ocean Trawl Survey are in strata that are within the VA Tech Survey sampling area. The ARM SC decided that the population estimate from VA Tech should not be altered due to spatial coverage. The ARM SC did discuss movement of crabs south of the Delaware Bay and current consideration of portions of Maryland and Virginia crabs to not be of Delaware Bay origin. Given new information on horseshoe crab movement in this region since the ARM Framework was established, the ARM SC recommended that the percentages of Maryland and Virginia crabs considered to be of Delaware Bay origin or part of the Delaware Bay regional population be reevaluated.

The ARM SC elected a new Chair, John Sweka, and Vice Chair, Jim Lyons.

Horseshoe Crab Adaptive Resource Management Subcommittee and Delaware Bay Ecosystem Technical Committee
Joint Meeting Summary

September 12, 2019

Delaware Bay Ecosystem Technical Committee Members: Greg Breese (Chair, USFWS), Henrietta Bellman (DE), Amanda Dey (NJ), Steve Doctor (MD), Mike Millard (USFWS), Wendy Walsh (USFWS), Jordan Zimmerman (DE)

On the phone: Eric Hallerman (VT), Adam Kenyon (VA)

Adaptive Resource Management Subcommittee Members: Jim Lyons (Chair, USGS), Lindy Barry (NJ), Henrietta Bellman (DE), Jason Boucher (DE), Steve Doctor (MD), Larry Niles (CWF), Dave Smith (USGS), John Sweka (USFWS), Wendy Walsh (USFWS)

ASMFC Staff: Michael Schmidtke, Kristen Anstead

Public: Brett Hoffmeister (HSC AP Vice Chair, ACC), Nora Blair (Charles River), Joe Smith

A joint meeting of the Delaware Bay Ecosystem Technical Committee (DBETC) and Adaptive Resource Management (ARM) Subcommittee (SC) took place on September 12, 2019, in Arlington, Virginia. The meeting's goals were to review and discuss the ARM SC's proposed changes to the ARM Framework, develop recommendations for the Horseshoe Crab Management Board (Board) about the proposed changes, review 2018 horseshoe crab and 2019 red knot surveys, and elect a new Chair and Vice Chair.

Jim Lyons and John Sweka presented the ARM SC's recommended changes to the ARM Framework for the DBETC's review and consideration for approval. Following a presentation of the proposed revisions, the DBETC asked questions and made some revisions. The consensus recommendations by the DBETC and ARM SC to the Board are:

1. **For input into the ARM Framework annually, combine the primiparous and multiparous abundances from the Virginia Tech Trawl Survey with a half year of mortality applied to the estimates. This would apply to the ARM Framework immediately.**

2. **Move forward with using CMSA model for estimation and projection as the underlying horseshoe crab population model in the ARM Framework. Reassess ARM utility of female horseshoe crab harvest as a function of female abundance.**

3. **Update red knot survival and mass gain model with most recent data. Evaluate red knot model weights.**

4. **Use of CMSA accounts for biomedical mortality in the ARM Framework (a previous Board task).**

5. **First, request the disclosure of confidential biomedical data for use in the base run CMSA estimate. If Board does not agree with making the request or the companies say no to the disclosure: Run the CMSA with the confidential biomedical data with 15% applied mortality, without biomedical data, and with non-confidential coastwide biomedical data with 15%**

applied mortality. The harvest package will be made based on the population estimates from the CMSA that includes confidential data, as it represents the best data set available. Publish 0% biomedical and coastwide biomedical population estimates as population bounds.

6. **Reevaluate definition of Delaware Bay crabs and the implications towards the population estimates and harvest allocations.**

The proposed changes to the ARM Framework would be conducted over a year or two and would require a peer review.

The committees reviewed the results of the 2018 Virginia Tech Trawl Survey by Eric Hallerman, New Jersey Ocean Trawl and Delaware Bay Trawl by Lindy Barry, and Delaware 16' and 30' Trawls by Jordy Zimmerman. As in previous years, the immature and newly mature male and female horseshoe crabs show variability and no trend. Mature males and females in the coastal area show an increasing trend since 2002, although the committee members had some disagreement about the interpretation of that trend and what statistical test was used. The swept area estimate of mature female horseshoe crabs in the region for fall 2018 was 7.3 (95% CI: 4.1- 10.5) million.

Jim Lyons presented the 2019 red knot mark-resight survey conclusions and population estimates. The pattern of red knot arrivals in the Delaware Bay in 2019 suggested an early arrival and a relatively high persistence probability. The estimated stopover population was 45,133 (95% CI: 42,269–48,393), similar to the estimate in 2018 of 45,221 (95% CI: 42,568–49,508). This superpopulation estimate accounts for turnover in the population and probability of detection. Mandy Dey gave an update on the status of red knot which stated that peak stopover in the Delaware Bay has been low and stable for a decade and horseshoe crab eggs have not shown an increase. Both reports noted that there has been a shift of red knot distribution to New Jersey beaches and few birds detected on Delaware beaches.

The horseshoe crab population estimates from the Virginia Tech Trawl Survey and the red knot estimates from mark-resight have been forwarded to Conor McGowan, who runs the current ARM model, to generate the 2020 fishing season's harvest package. Additionally, Joe Smith discussed some recent work his research group has conducted regarding horseshoe crab egg density trends which indicates that beaches are not saturated with eggs to levels that compare with previous (1990s) estimates.

The DBETC elected a new Chair, Wendy Walsh, and Vice Chair, Henrietta Bellman.