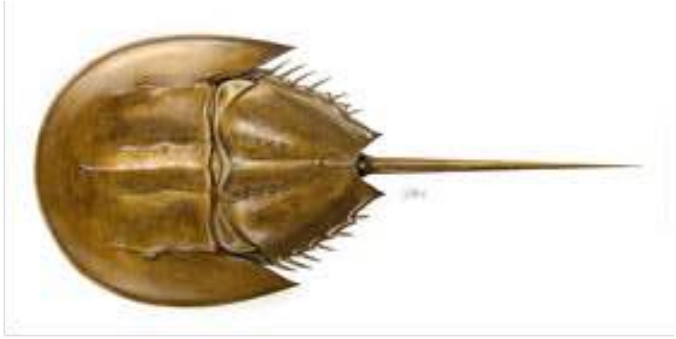
Atlantic States Marine Fisheries COMMISSION

Review of Delaware Bay Bait Harvest Specifications

Horseshoe Crab Management Board

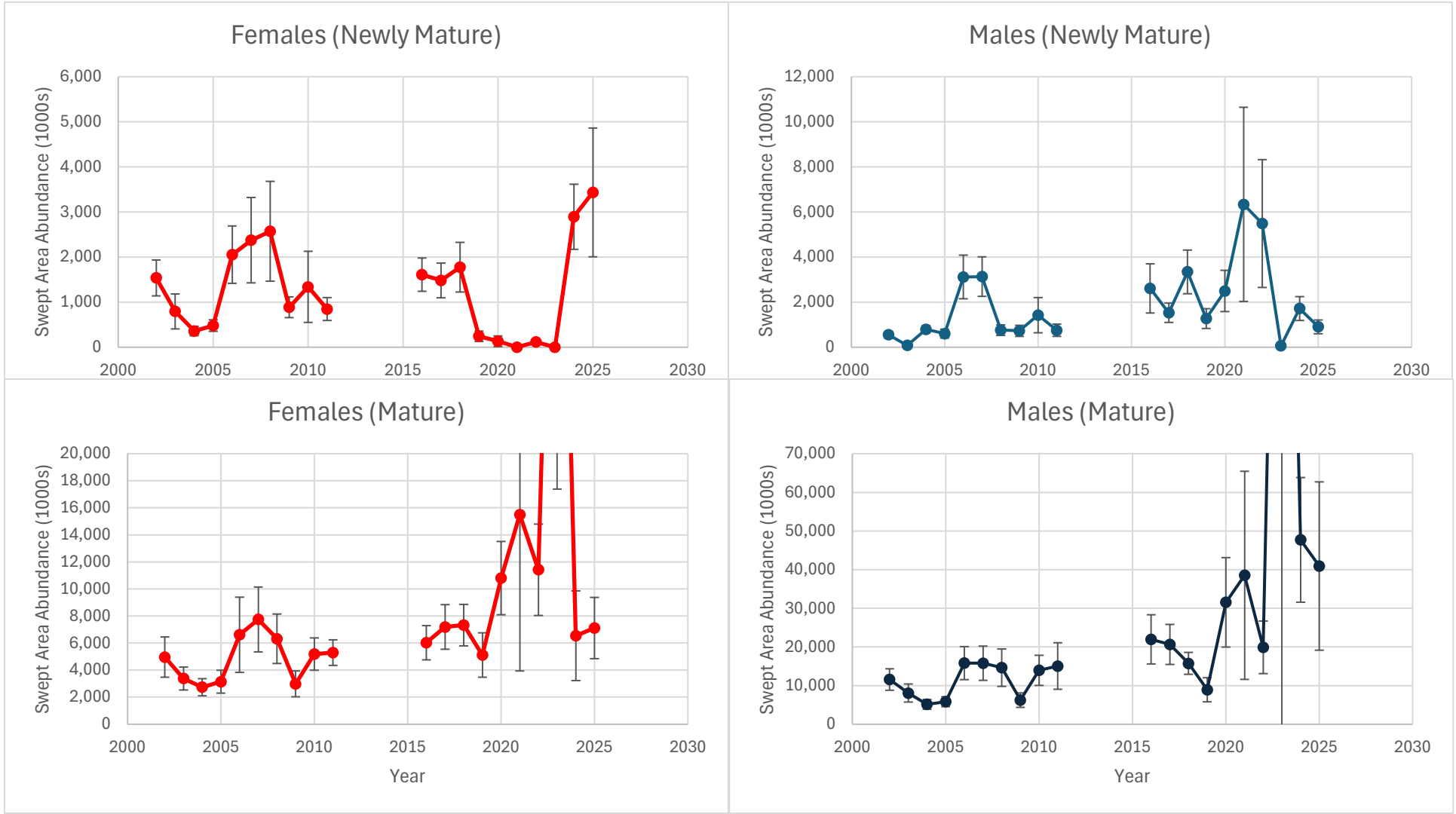
November 10, 2026



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Review of Horseshoe Crab Surveys

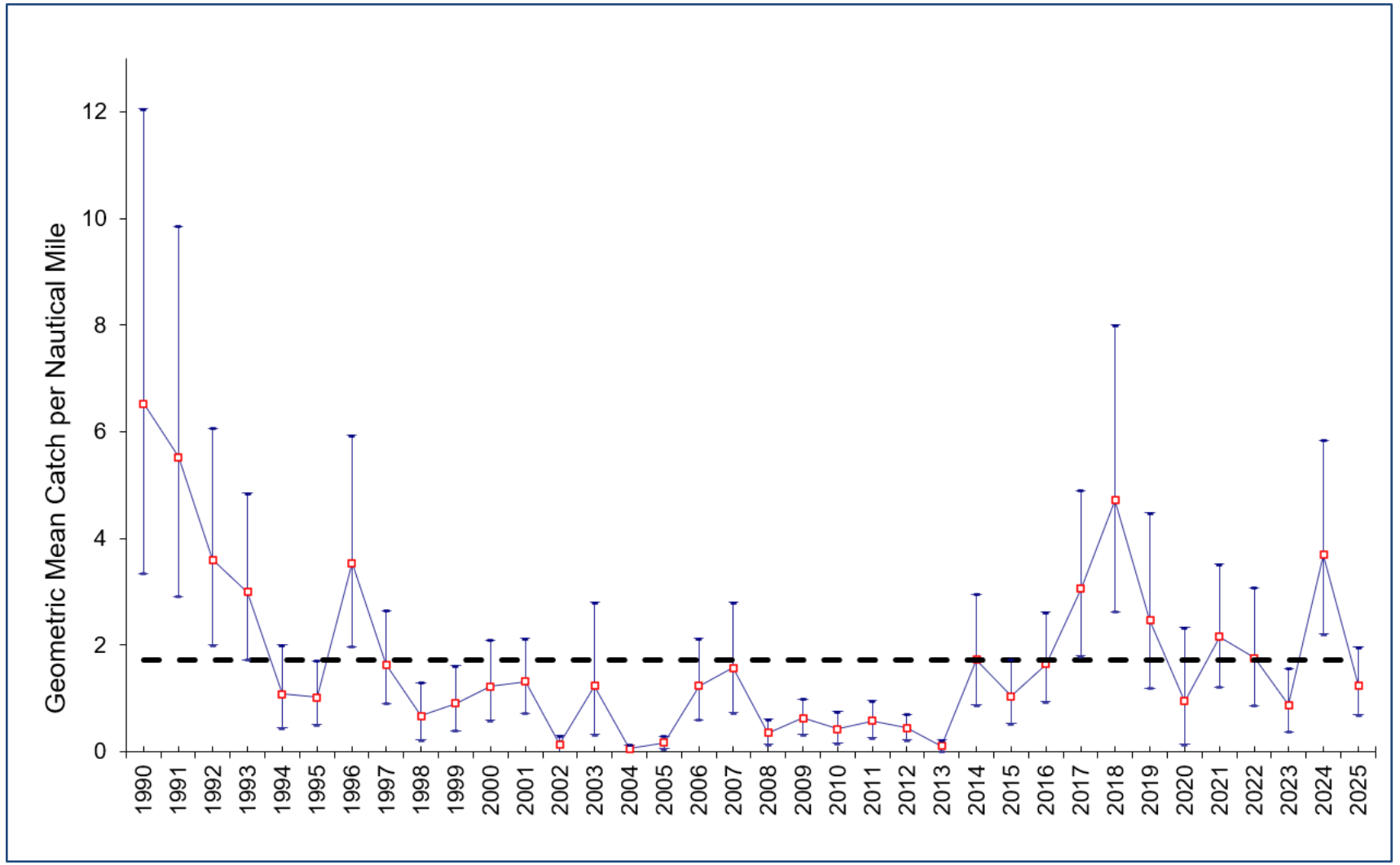
Virginia Tech Trawl Survey Swept Area Abundance Estimates



Atlantic States Marine Fisheries COMMISSION

Review of Horseshoe Crab Surveys

Delaware 30 ft. Trawl (April – July)



Review of Horseshoe Crab Surveys

NJ Ocean Trawl

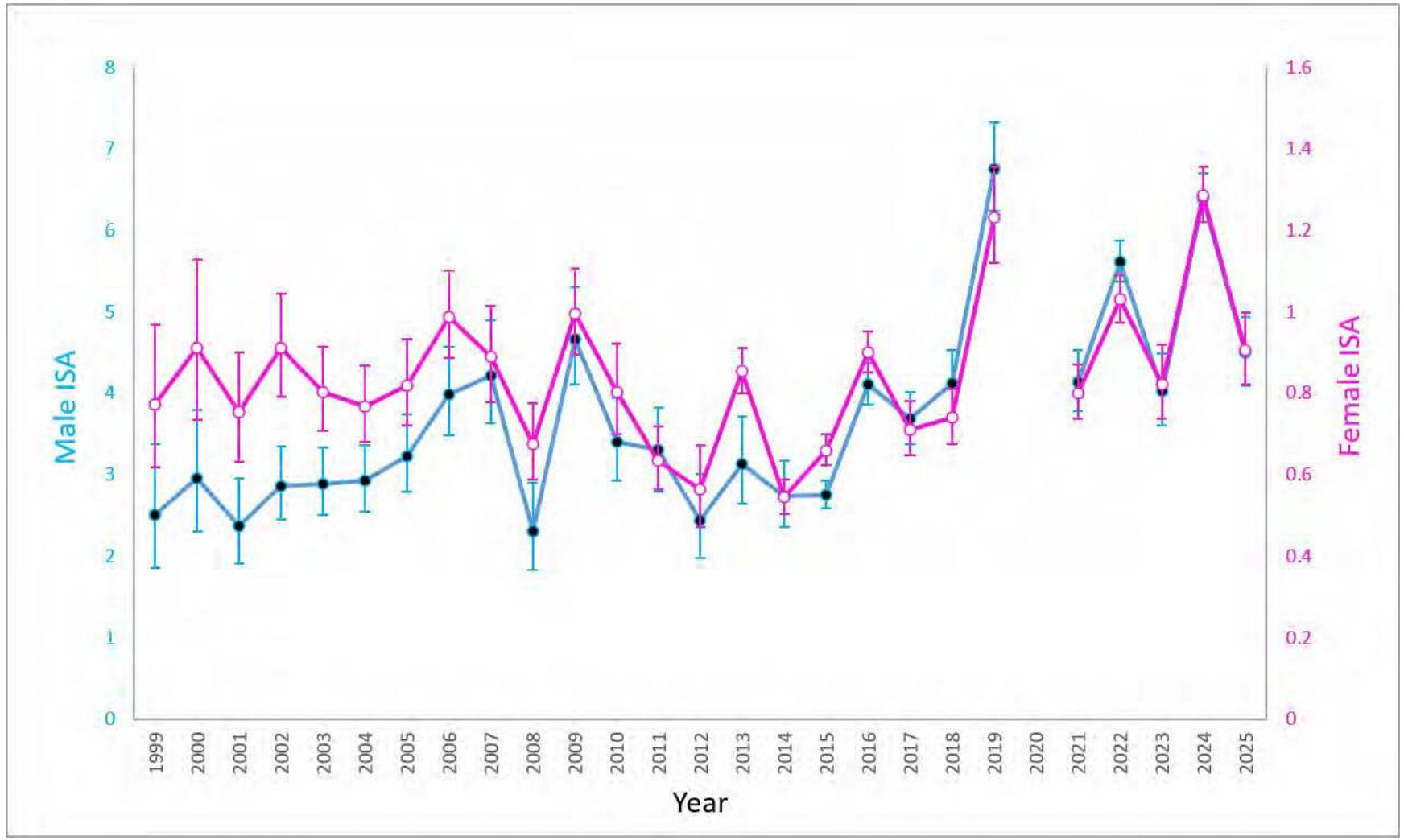
Not Conducted in 2025 due to vessel maintenance

Back on track for 2026

Atlantic States Marine Fisheries COMMISSION

Review of Horseshoe Crab Surveys

Delaware Bay Spawning Survey



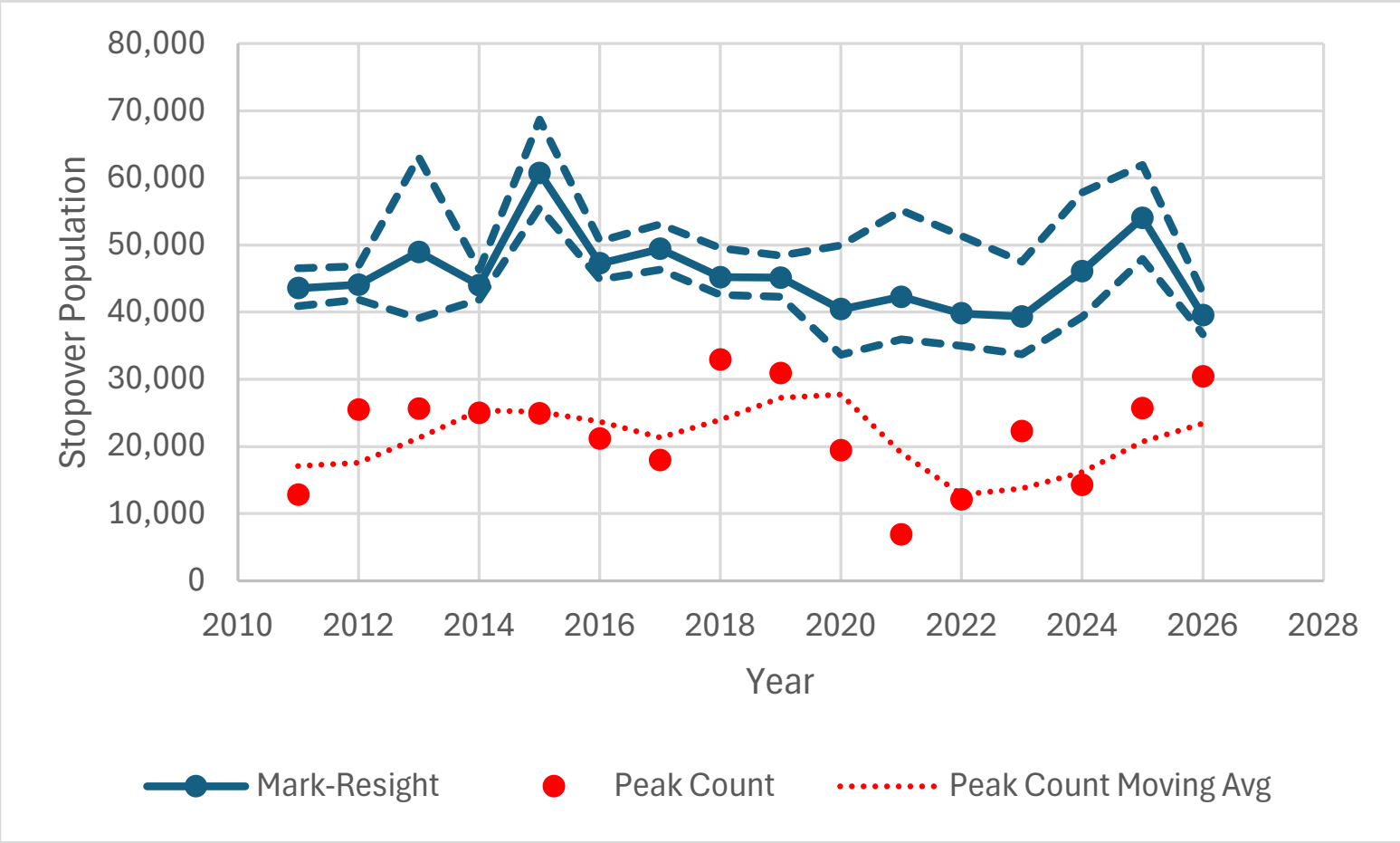
2025 Sex Ratio
5 Males:1 Female

10-year average
5.2 Males:1 Female

Atlantic States Marine Fisheries COMMISSION

Red Knot Surveys

Mark-Resight Population Estimate and Counts



2025: 54,044 (47,926 – 61,928)
2026: 39,534 (36,740 – 42,922)

Questions

Questions on horseshoe crab or red knot surveys?

Atlantic States Marine Fisheries COMMISSION

2027 DE Bay Harvest Specifications

- Addendum IX allows the Board to set harvest specifications for male-only harvest for up to 3 years at a time based on the ARM recommendation
- In 2025, the ARM recommended 500,000 male harvest
- The Board elected to institute male-only harvest for 2 years
- The spawning beach sex ratio remains >3:1 (5:1 in 2025), therefore male-only harvest can remain at 500,000 crabs
- **DBETC recommends maintaining specifications for 2027**

Atlantic States Marine Fisheries COMMISSION

2027 DE Bay Harvest Specifications

No Female Harvest and 2-to-1 offset per Addendum IX:

State	Delaware Bay-Origin Quota		Total Quota	
	Male	Female	Male	Female
Delaware	173,014	-	173,014	-
New Jersey	173,014	-	173,014	-
Maryland	132,864	-	255,980	-
Virginia	21,107	-	81,331	-
TOTAL	**500,000**	-	**683,339**	**-**

Questions

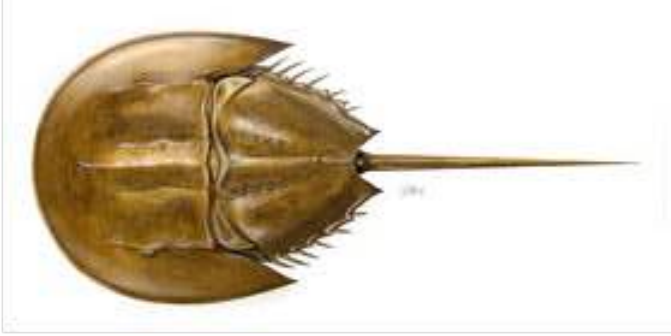


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Consider Updates to Adaptive Resource Management (ARM) Framework Model Reward, Utility and Harvest Policy Functions

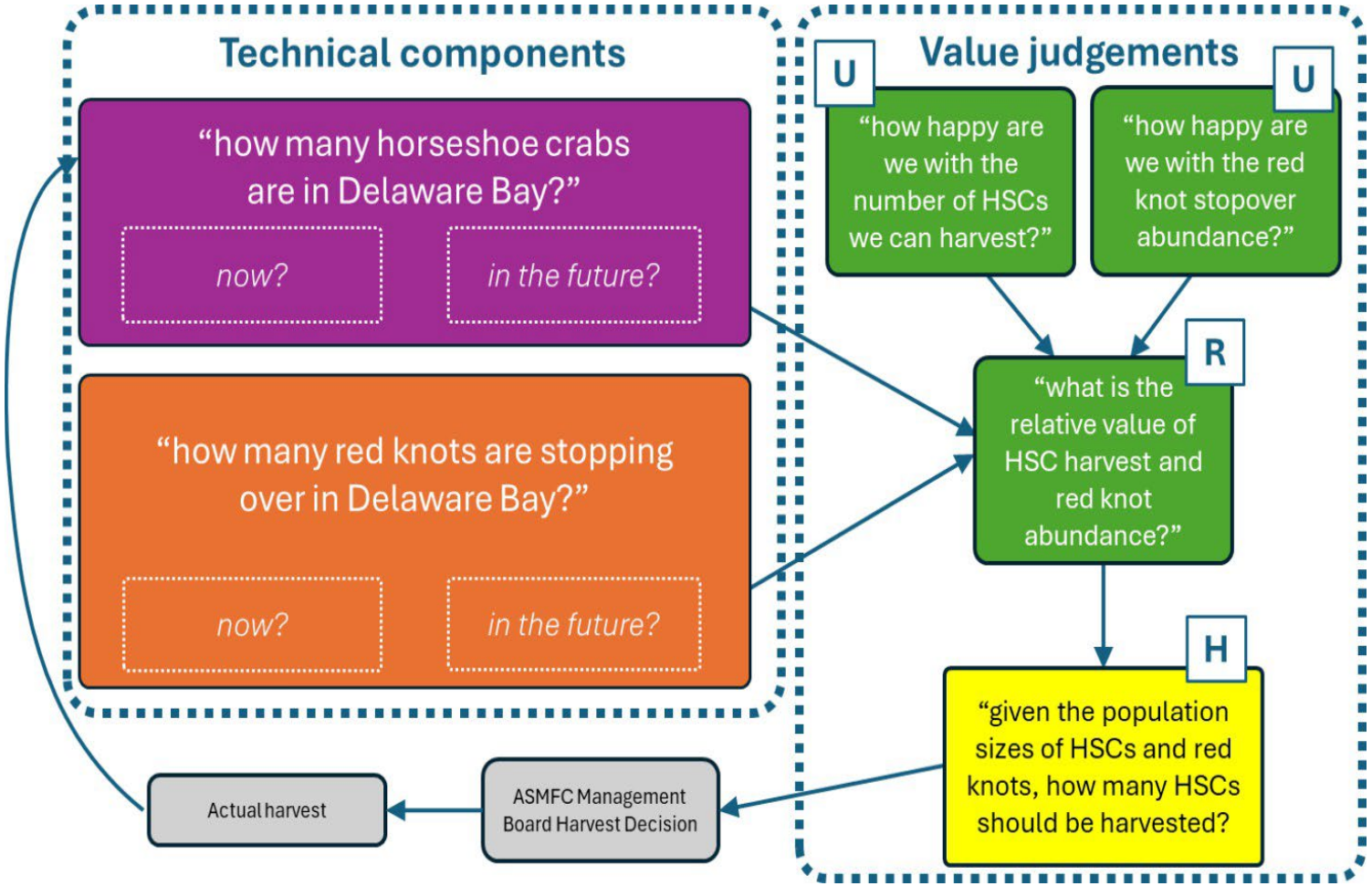
Horseshoe Crab Management Board

November 10, 2026



Background

Simplified Diagram of the ARM Decision Model



Background

Utility Function: How happy are we?

- HSC Harvest (u^h) : Proportional value of the maximum allowable harvest value
- Red Knot Abundance (u^k) : The stopover population of red knots

Reward Function: The combination of utilities

- Reward = $u^h + u^k + u^h \cdot u^k$

Harvest Policy Functions: What we solve for to maximize the long-term average reward

Background

Stakeholder Engagement (2025 – 2026)

- Educational Workshops in the fall/winter
- Facilitated workshop January 2026 with Compass Resource Mgt. Ltd.
- Final report and recommendations presented at the Spring 2026 meeting
  - Change to the harvest utility function to reflect the current value of bait harvested females relative to males
  - Updated red knot utility function based on stakeholder values
  - Retain the reward function as in the 2021 ARM Revision
  - Add threshold for zero female horseshoe crab harvest as a “safety-net”

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Error in 2021 ARM model code

<u>Discovery of an error in the code for the reward function</u>

Two ways in which "harvest" is handled in the ARM Framework:

1. The bait harvest (what is usually meant by "harvest" in the ARM Framework)
2. Total anthropogenetic HSC mortality including:
   a) Bait Harvest
   b) "Background Harvest" – additional mortality from biomedical and dead discards

In the population model #2 is used to calculate annual population, but #1 should be used when calculating annual reward

Atlantic States Marine Fisheries COMMISSION

Error in 2021 ARM model code

Intended harvest utility:

$$u_t^h = \frac{2H^f + H^m}{2H_{max}^f + H_{max}^m}$$

The Error:

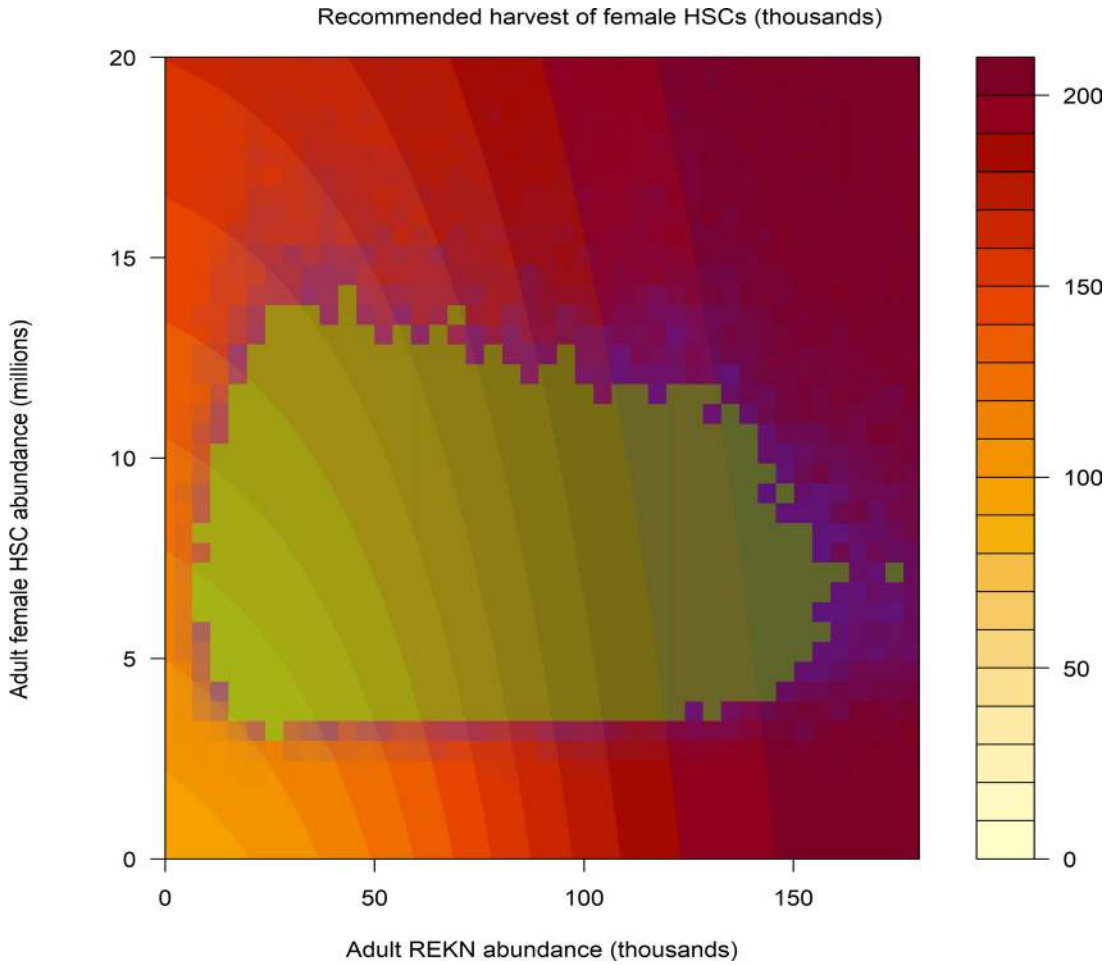
$$u_t^h = \frac{2(H^f + BG^f) + H^m}{2H_{max}^f + H_{max}^m}$$

The 2021 ARM optimized for bait + background harvest. This resulted in the optimal bait harvest level being lower than it should have been because the model was solving for the optimal (near 210K) and then subtracting out the background harvest.

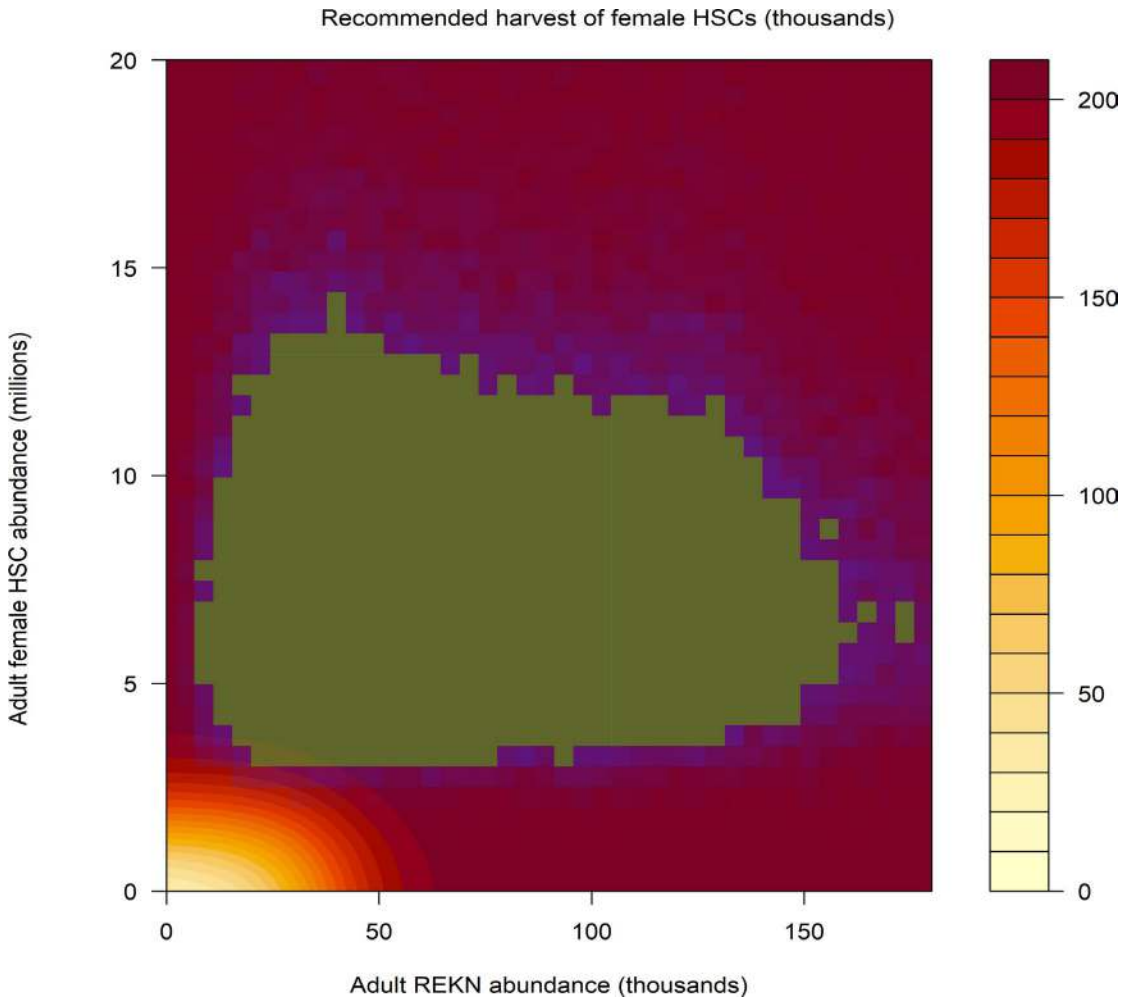
Atlantic States Marine Fisheries COMMISSION

Error in 2021 ARM model code

Rev2021



errFix



Atlantic States Marine Fisheries COMMISSION

Error in 2021 ARM model code

Ramifications of fixing the error:

- Projected female harvest in year 100 is 16.3% higher that in the 2021 version
- However, only a -0.5% decrease in red knot abundance, and -1.3% decrease in female HSC abundance

***This change needs to be made and carried forward if the ARM is to operate as intended by the modelers, peer-reviewed in the 2021 revision, and understood and agreed to by stakeholders.**

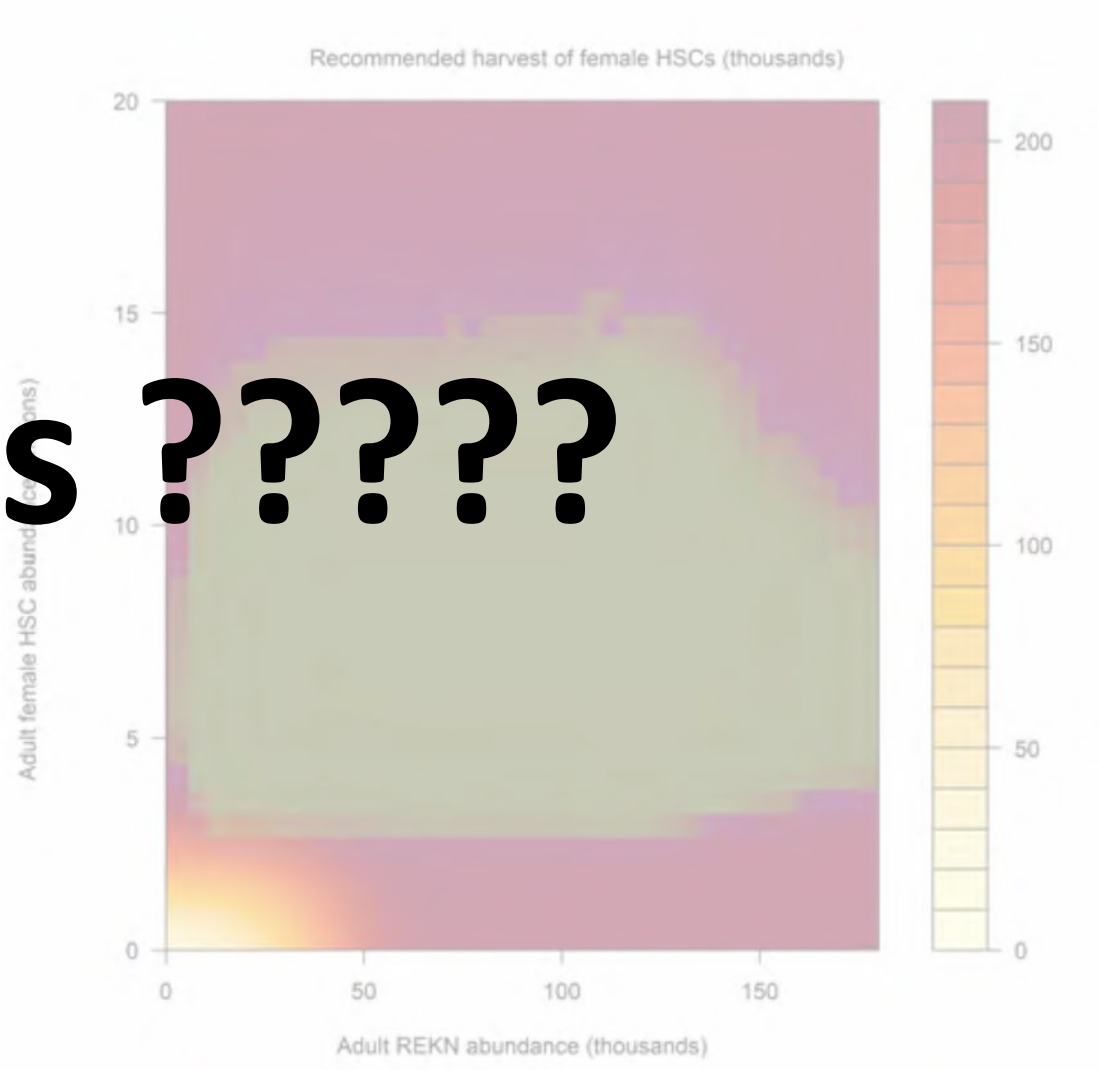
Atlantic States Marine Fisheries COMMISSION

Error in 2021 ARM model code

Rev2021



errFix



Questions ?????

Atlantic States Marine Fisheries COMMISSION

Stakeholder Workshop Changes

HSC Harvest Utility Change

ARM 2021:

$$u_t^h = \frac{2H^f + H^m}{2H_{max}^f + H_{max}^m}$$

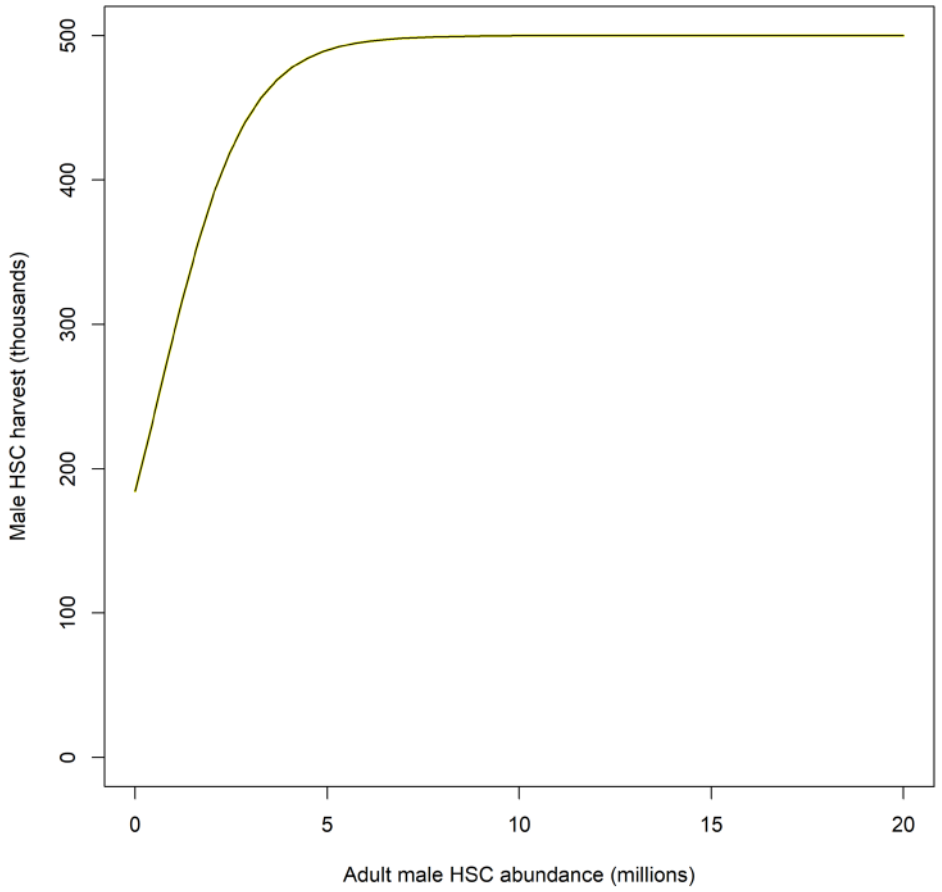
Workshop Change:

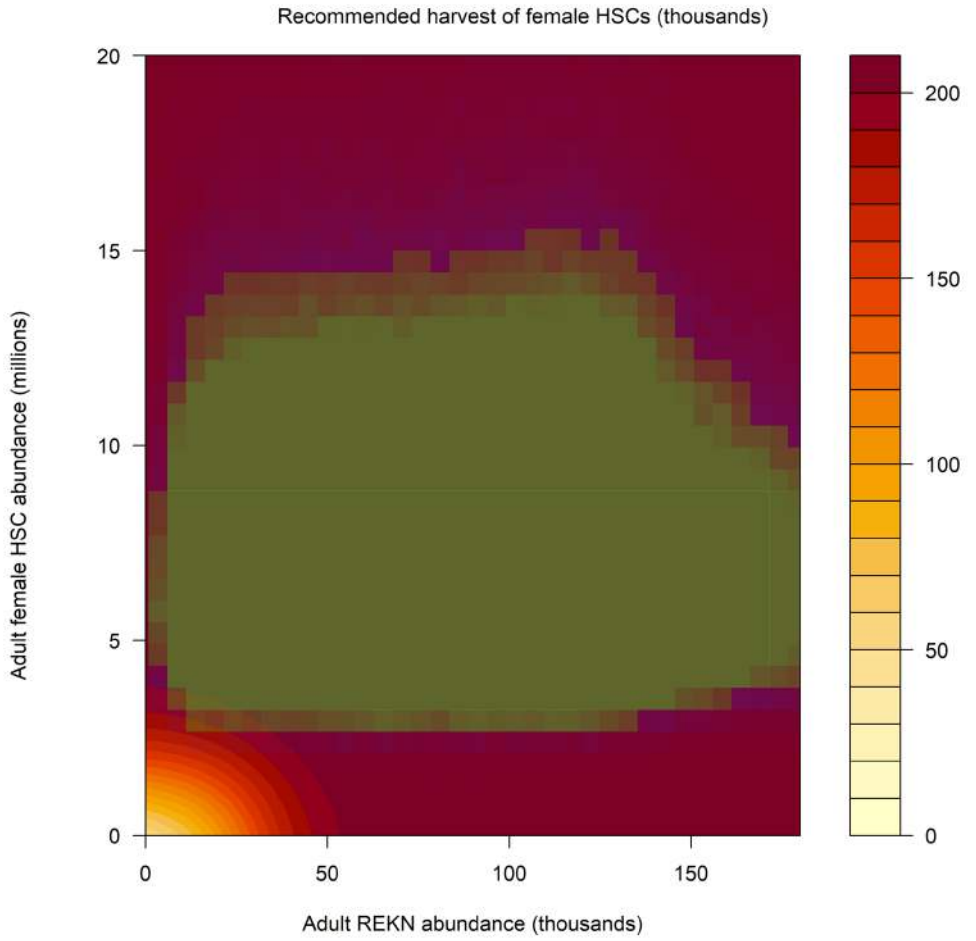
$$u_t^h = \frac{2.65H^f + H^m}{2.65H_{max}^f + H_{max}^m}$$

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Stakeholder Workshop Changes

Harvest Policy for HSC Harvest Utility Change



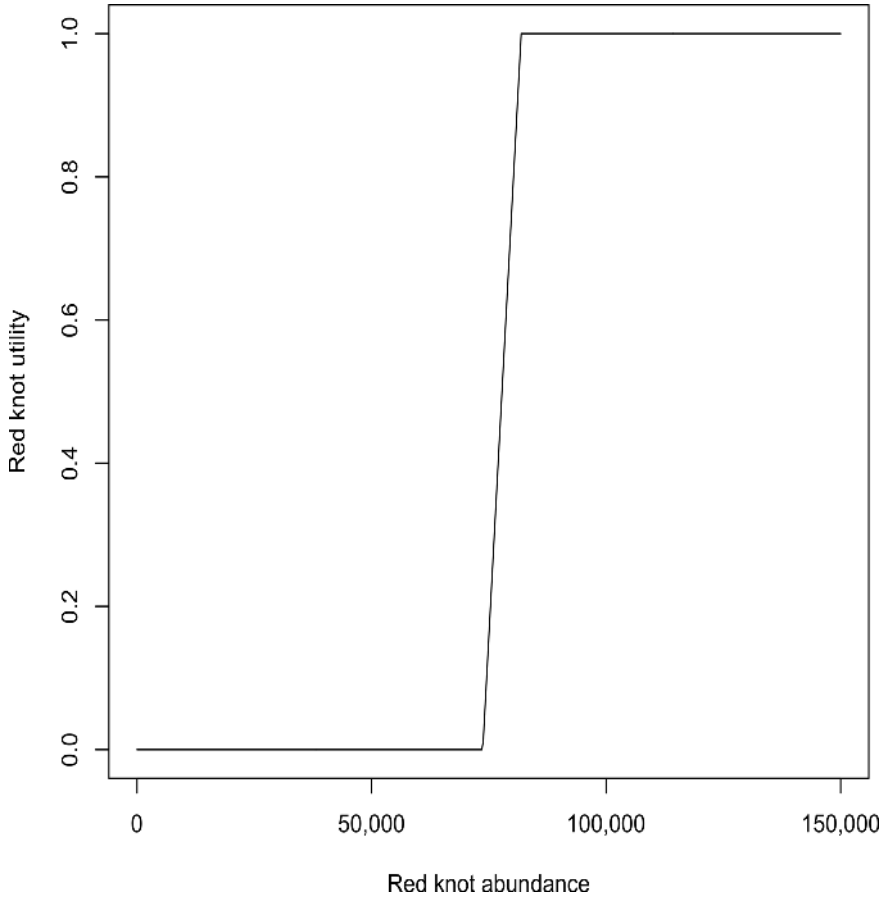


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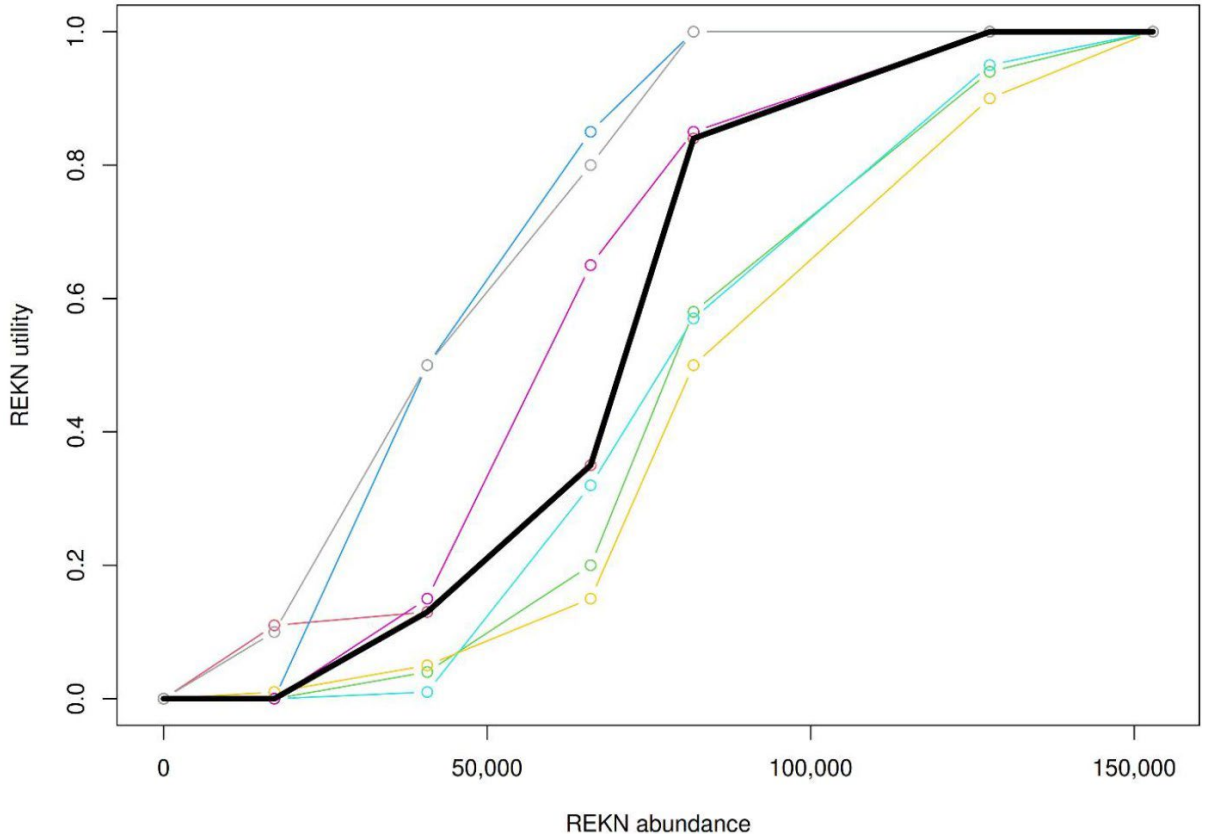
Stakeholder Workshop Changes

Red Knot Utility Change

ARM 2021:



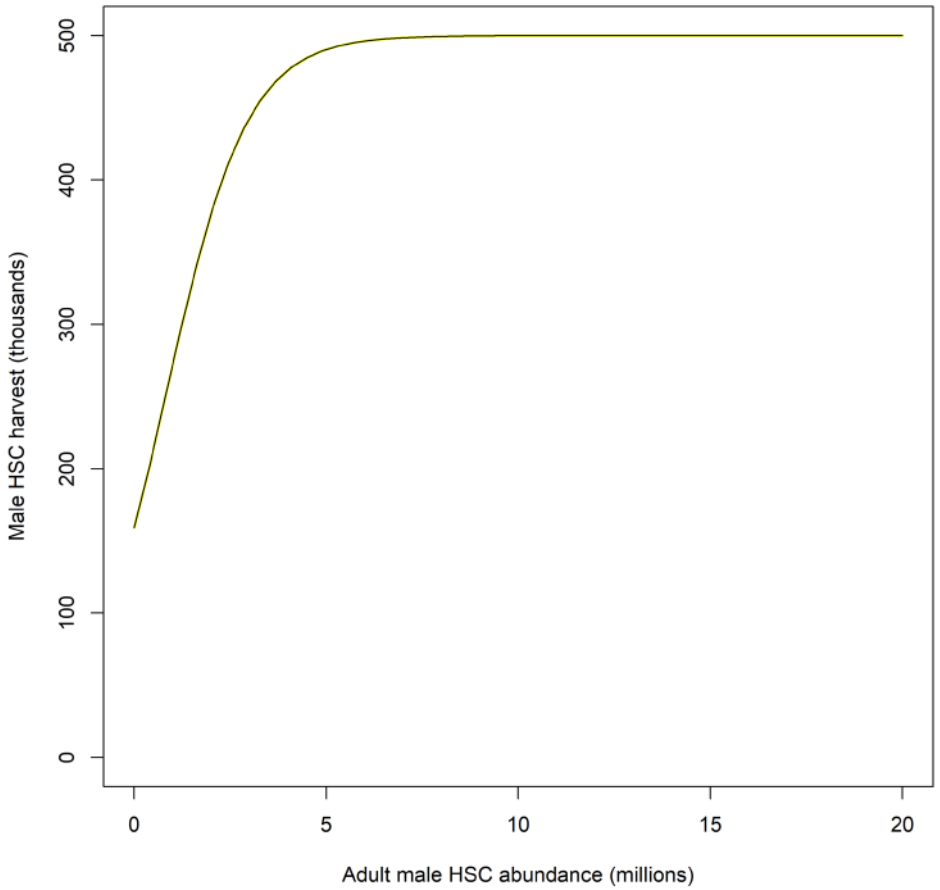
Workshop Change:

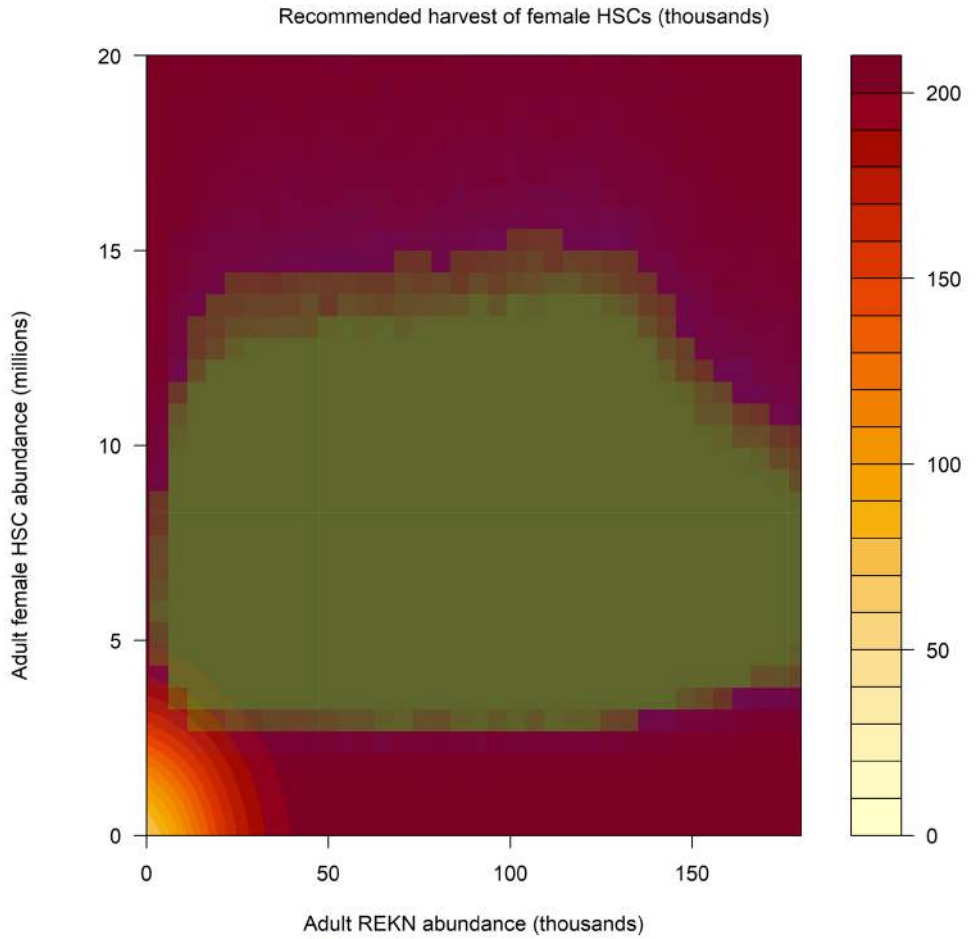


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Stakeholder Workshop Changes

Harvest Policy for HSC Harvest Utility Change + Red Knot Utility Change





Stakeholder Workshop Changes

Female Harvest Factor Change

ARM 2021: Optimized over all ranges HSC and Red Knot abundance

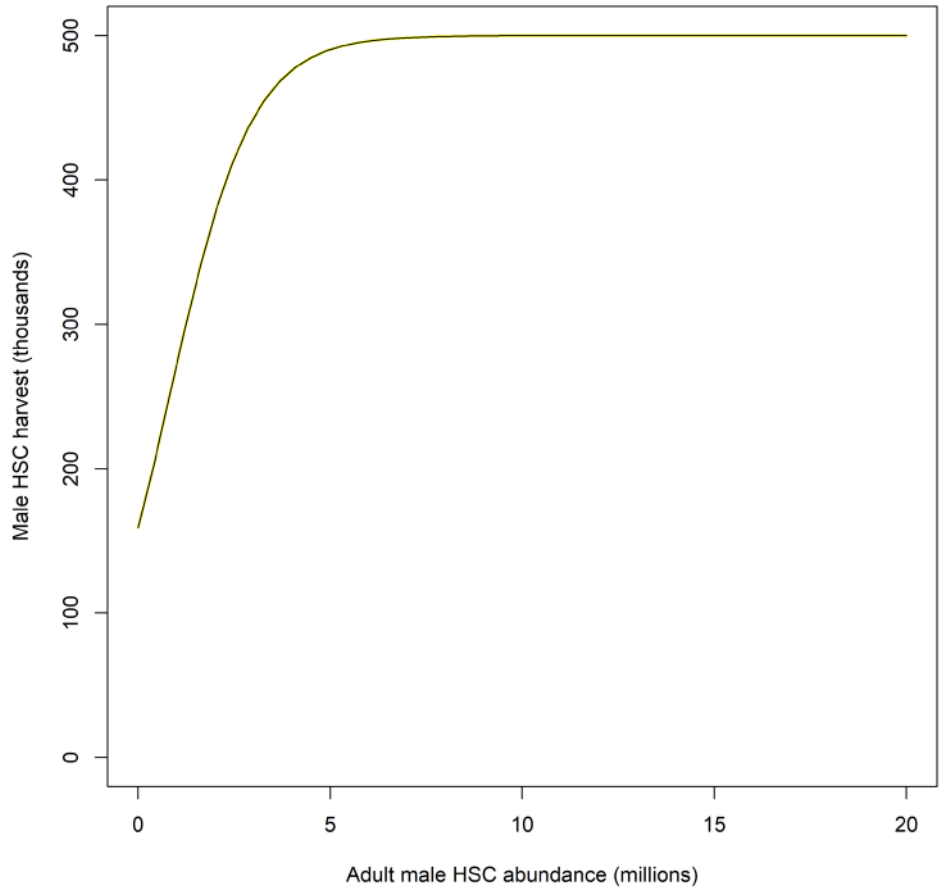
Workshop Change: Added the constraint that there would be no female harvest permitted if female abundance was below some threshold level; no additional constraints on male harvest

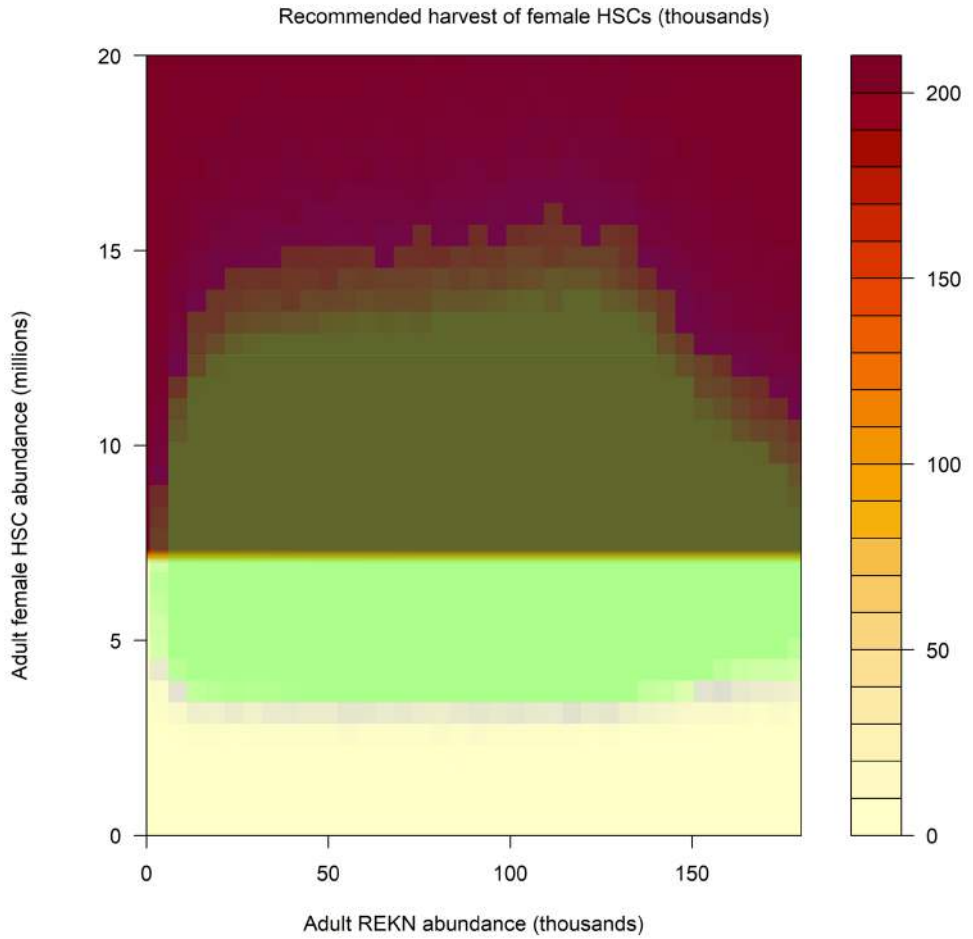
- A 7 million threshold was then elicited from the DBETC/ARM SC as stakeholders were not comfortable selecting a number

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Stakeholder Workshop Changes

Harvest Policy for All Workshop Changes

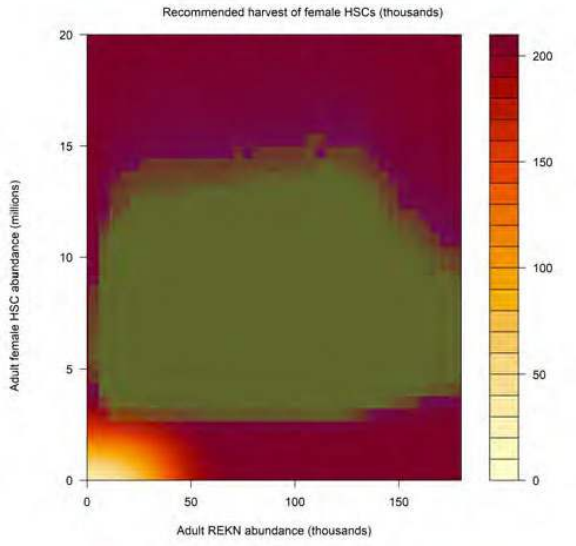




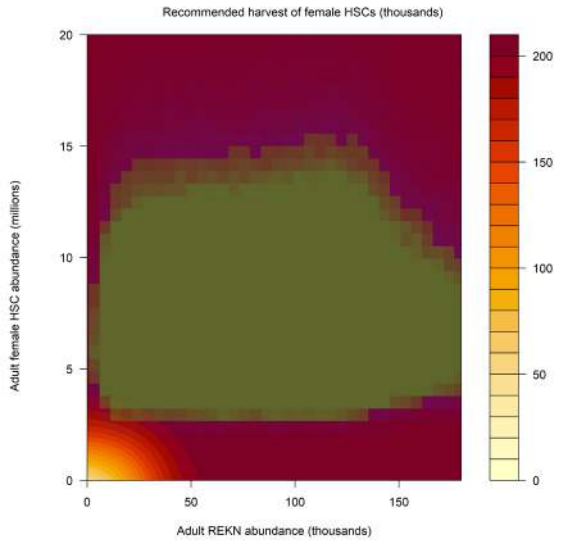
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Stakeholder Workshop Changes

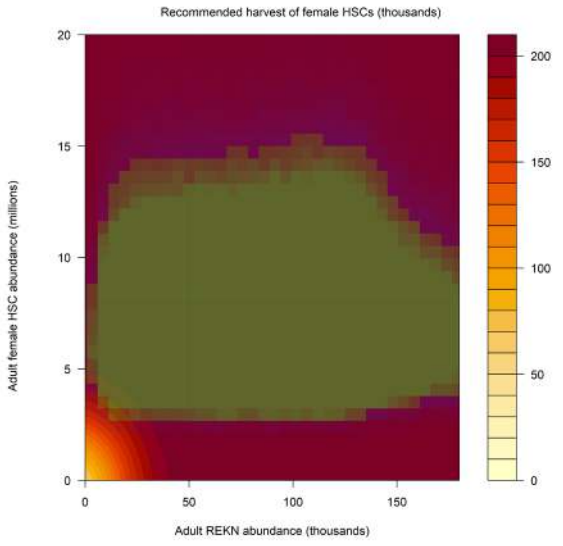
ARM 2021 errFix



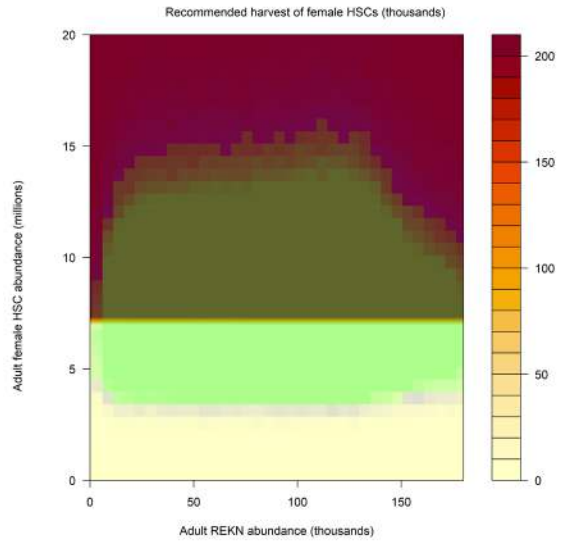
HSC Utility



RKN Utility



All Workshop Changes

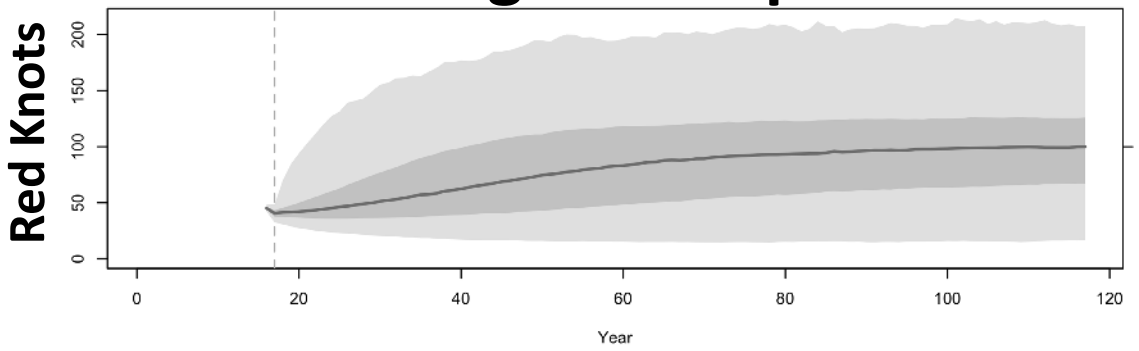


NOTE: The shape and size of the “green blob” remains consistent indicating that any of these changes will have no significant effect on predicted future population size of female horseshoe crabs or red knots

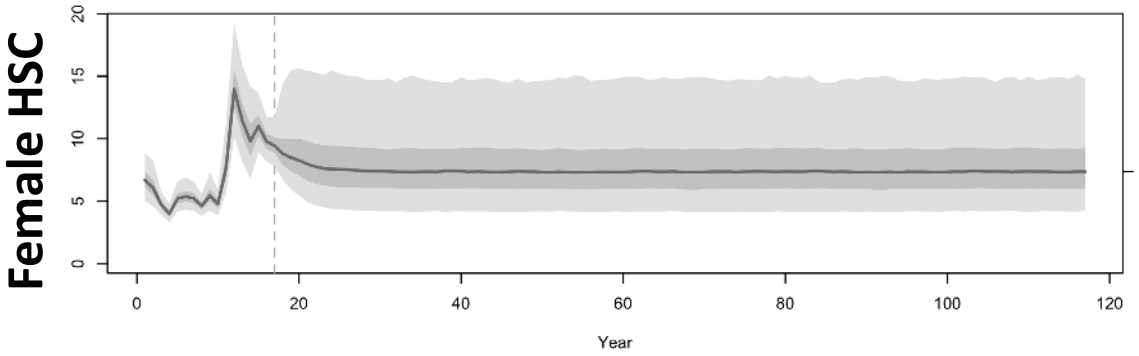
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Stakeholder Workshop Changes

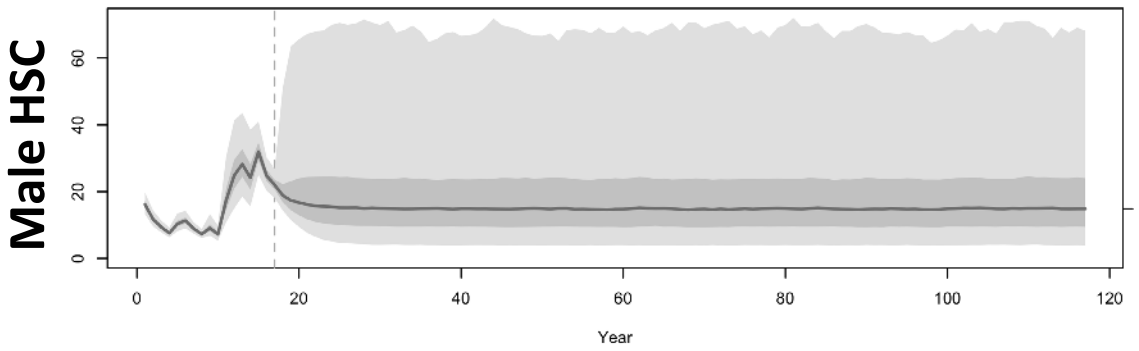
All Changes Incorporated



100 thousand



7.4 million



14.9 million

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Stakeholder Workshop Changes

Summary of changes

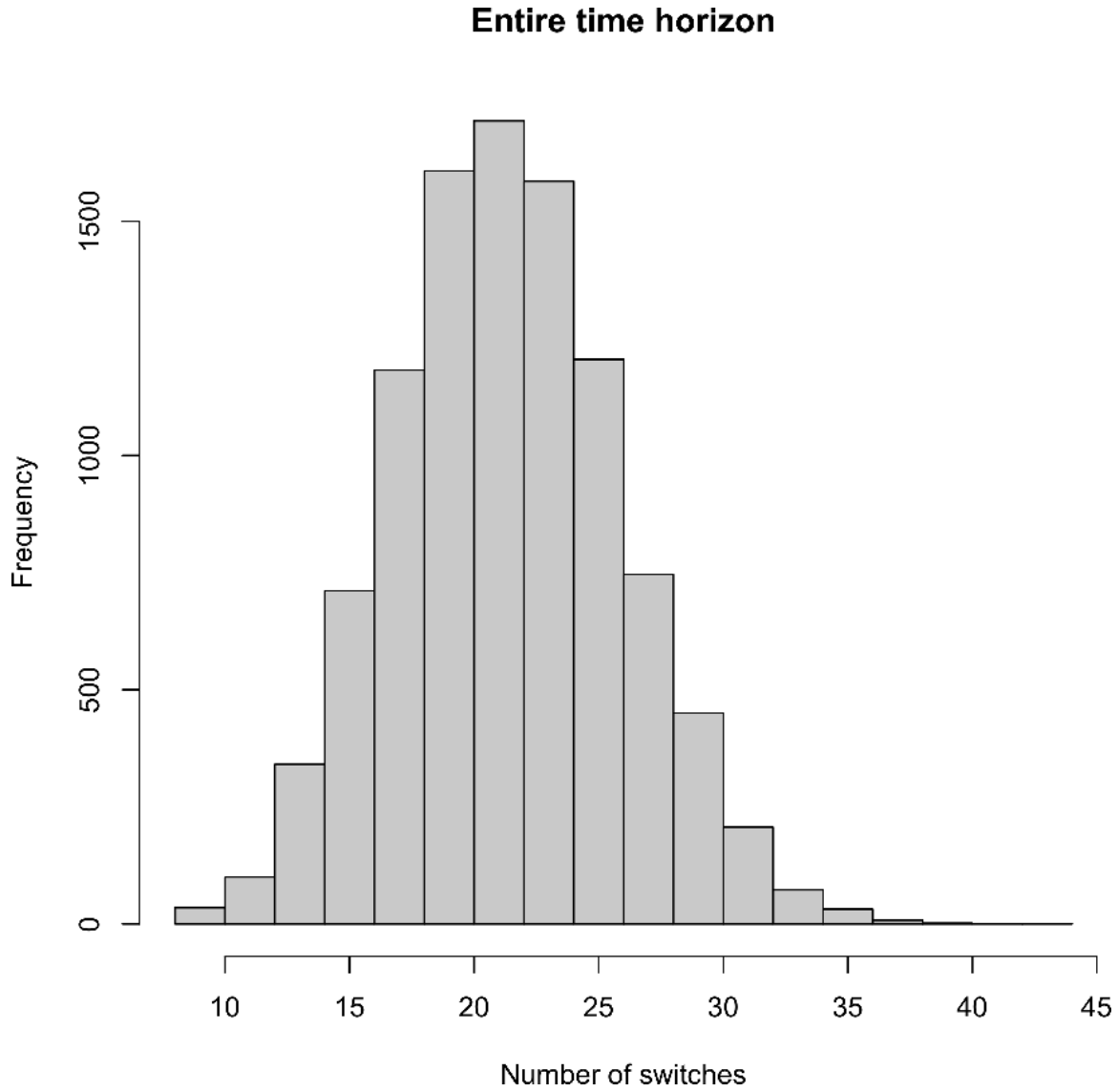
	Expected value, year 100					Percent change from previous model run				
Model Run	**Red Knots**	**Female HSC**	**Male HSC**	**Female Harvest**	**Male Harvest**	**Red Knots**	**Female HSC**	**Male HSC**	**Female Harvest**	**Male Harvest**
errFix	9.87e4	7.1e6	1.49e7	2.1e5	5.0e5					
hscUtil	9.87e4	7.1e6	1.49e7	2.1e5	5.0e5	0	0	0	0	0
rknUtil	9.86e4	7.1e6	1.49e7	2.1e5	5.0e5	**-0.1**	0	0	0	0
femThresh	1.0e5	7.4e6	1.49e7	1.17e5	5.0e5	**+1.4**	**+4.2**	0	**-44.3**	0

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Stakeholder Workshop Changes

Incorporation of the 7 million female threshold will result in frequent female harvest switching

- Jump from 0 to 210K or from 210K to 0
- Median of 22 switches over 100 year
- Expect a switch once every 4.5 years



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Stakeholder Workshop Changes

An obvious question: Why would the ARM recommend maximum female harvest as soon as the 7 million female HSC abundance threshold is crossed?

1. **The harvest decision space is highly constrained**
   a) 210K maximum allowable harvest
   b) 7 million female abundance threshold for female harvest to occur

2. **A harvest of 210,000 females is very small relative to:**
   a) Expected future population sizes
   b) Expected numbers that would die due to natural mortality
   c) Expected number of recruits that would enter the adult population the next year

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Possible Next Steps

Remember, all population dynamics parameters and data were held constant in the results presented here (i.e., ARM 2021 values and parameters)

No information about the system after 2019 has yet been incorporated

The next update in 2027 will:

- Add HSC and red knot data since 2019
- Update the relationship between red knot survival and HSC abundance
- Update recruitment parameters for HSC
- Maintain the values-based decisions presented here (pending Board decision)
- Run the optimization with updated population dynamics data
- Provide revised harvest policies inclusive of the additional population dynamics knowledge

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Marine Fisheries
COMMISSION

Questions



Atlantic States
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COMMISSION

Advisory Panel Report



November 10, 2026

Atlantic States Marine Fisheries COMMISSION

Background

- 12 members of HSC Advisory Panel met virtually at 3pm on October 20, 2026
- The AP was provided a review of the recommendations from stakeholder engagement process and the proposed updates to the ARM model that were developed in response to these recommendations.

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AP Input on ARM Updates

- There was general support for proposed updates to the horseshoe crab and red knot utility functions to reflect stakeholder values
- However, several advisors expressed concerns about the threshold for female horseshoe crab harvest of 7 million females
  - Concern about female harvest recommendation potentially switching back and forth between 0 and 210,000
  - Similar in effect to the “knife-edge” utility function in original ARM Framework which was criticized and had a threshold of 11 million females. Gradual harvest was the output of the new model.
  - Discussed that the effect of this threshold is different in the corrected model compared to the uncorrected model and stakeholders have not reviewed the change

Other Comments

- Comments and questions regarding the potential / future inclusion of changes to habitat, environmental conditions, and bycatch levels to impact population projections in the ARM Framework
- Harvest levels output by the ARM Framework should be utilized because not implementing it undermines the model's predictions and learning ability. The ARM cannot "learn" and function if the outputs are not utilized

- Comment on the importance of having more males than females for successful horseshoe crab reproduction. Should there be a threshold for a minimum number of males implemented?
- The AP Ajourned at 4:30PM

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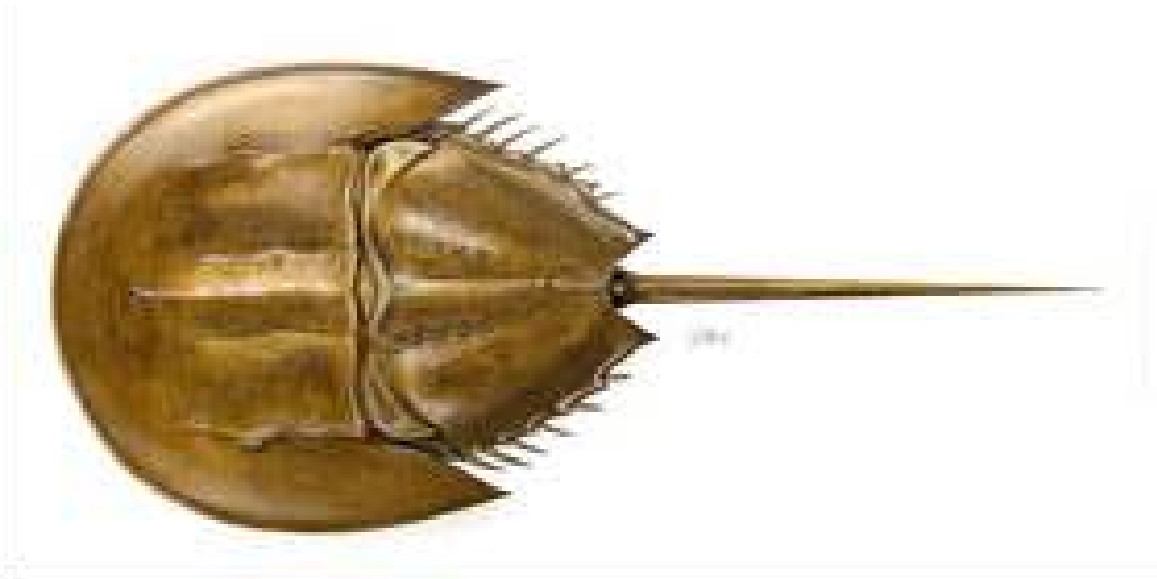
Board Action

- Consider initiating an addendum to implement the changes to the ARM utility and harvest policy functions based on stakeholder input
  - *Does the Board want the Addendum to consider each change individually, or as one package?*

- Possible timeline if initiated today:
  - January: Board considers Draft Addendum for public comment
  - Feb-March: Public comment period and hearings
  - May: Board considers Addendum for final approval
  - Spring/Summer: 2027 ARM Updates
  - October: Board sets DE Bay specifications using updated ARM

Atlantic States Marine Fisheries COMMISSION

Horseshoe Crab FMP Review for the 2025 Fishing Year



November 2026

Atlantic States Marine Fisheries COMMISSION

Presentation Outline

1. Status of the FMP
2. Status of the Stock
3. Status of the Fishery
4. Compliance Review
5. *De Minimis* requests
6. PRT Recommendations
7. Board action

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Status of the FMP

- **FMP Approved (1998)**
- **Addendum I (2000) –** State bait harvest quotas & *de minimis*
- **Addendum II (2001) –** Quota transfers
- **Addendum III (2004) –** DE Bay state bait quotas & seasonal closures
- **Addendum IV (2006) –** DE Bay state bait quotas & seasons
- **Addendum V (2008) –** Extension of Add IV
- **Addendum VI (2010) –** Extension of Add V
- **Addendum VII (2012) –** DE Bay ARM Framework
- **Addendum VIII (2022)** – Adopted ARM Revision
- **Addendum IX (2025) –** Allows multi-year male-only specs for DE Bay

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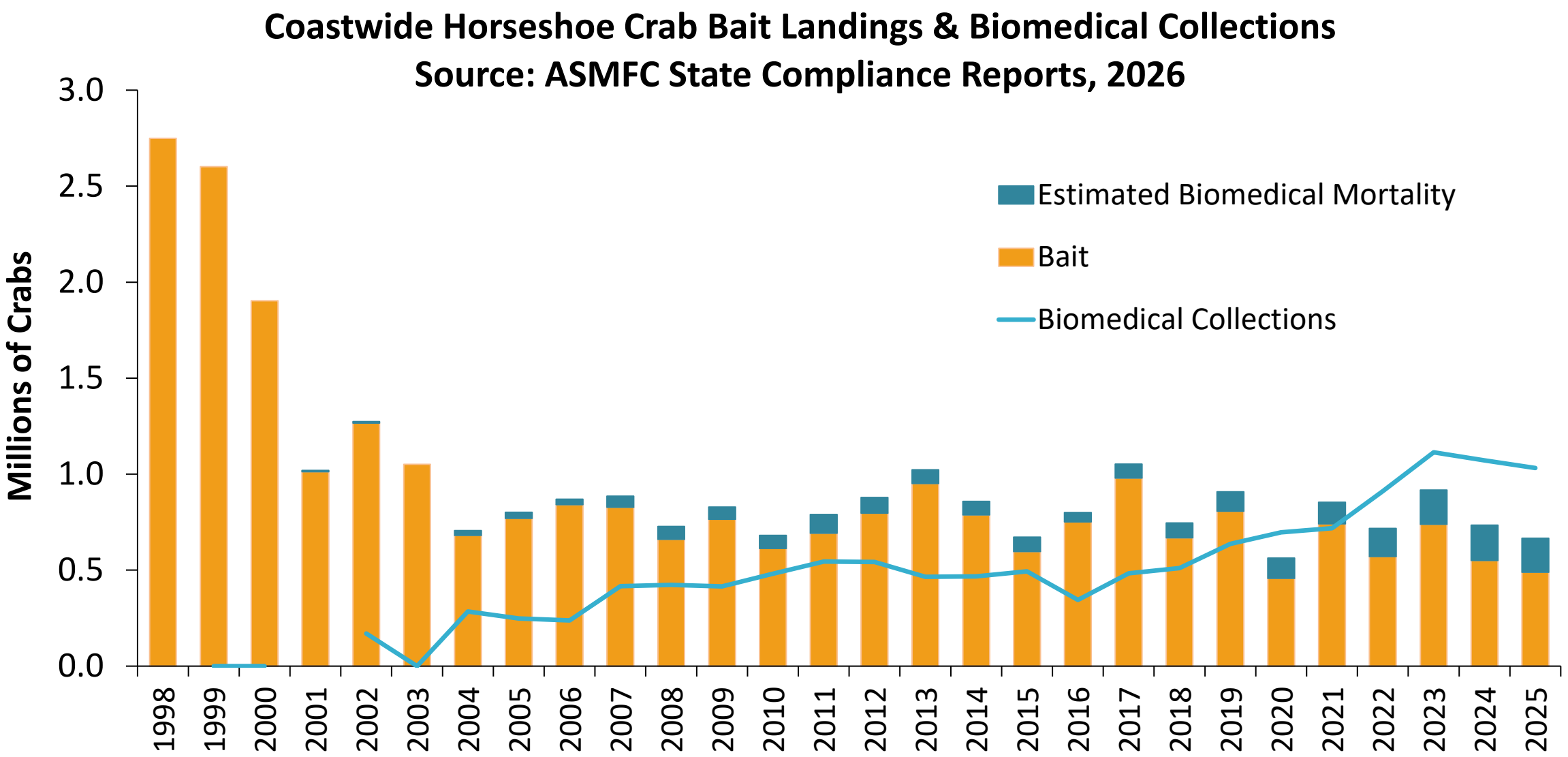
Status of the Stock

- Benchmark stock assessment peer reviewed in 2019, updated in 2024
- Regional status based on trend-analysis relative to 1998
- DE Bay population estimates using catch multiple survey analysis (CMSA)

Region	2009 Benchmark	2013 Update	2019 Benchmark	2024 update	2024 Stock Status
Northeast	2 out of 3	5 out of 6	1 out of 2	1 out of 2	Neutral
New York	1 out of 5	3 out of 5	4 out of 4	3 out of 4	Poor
Delaware Bay	5 out of 11	4 out of 11	2 out of 5	0 out of 5	Good
Southeast	0 out of 5	0 out of 2	0 out of 2	0 out of 2	Good
Coastwide	7 out of 24	12 out of 24	7 out of 13	4 out of 13	Good

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Status of the Fishery



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Bait Fishery

- Total 2025 coastwide harvest was 488,887 crabs
  - *RI, NC, GA, and FL landings are confidential*
  - 11% decrease from 2024 landings of 550,908
- 30% of ASMFC coastwide quota
- Almost all harvest is from MA (28%), NY (15%), DE (25%), MD (11%), and VA (20%)
- 81% of bait landings were male, 15% were female, and 4% were unclassified in 2025
  - MA data not included

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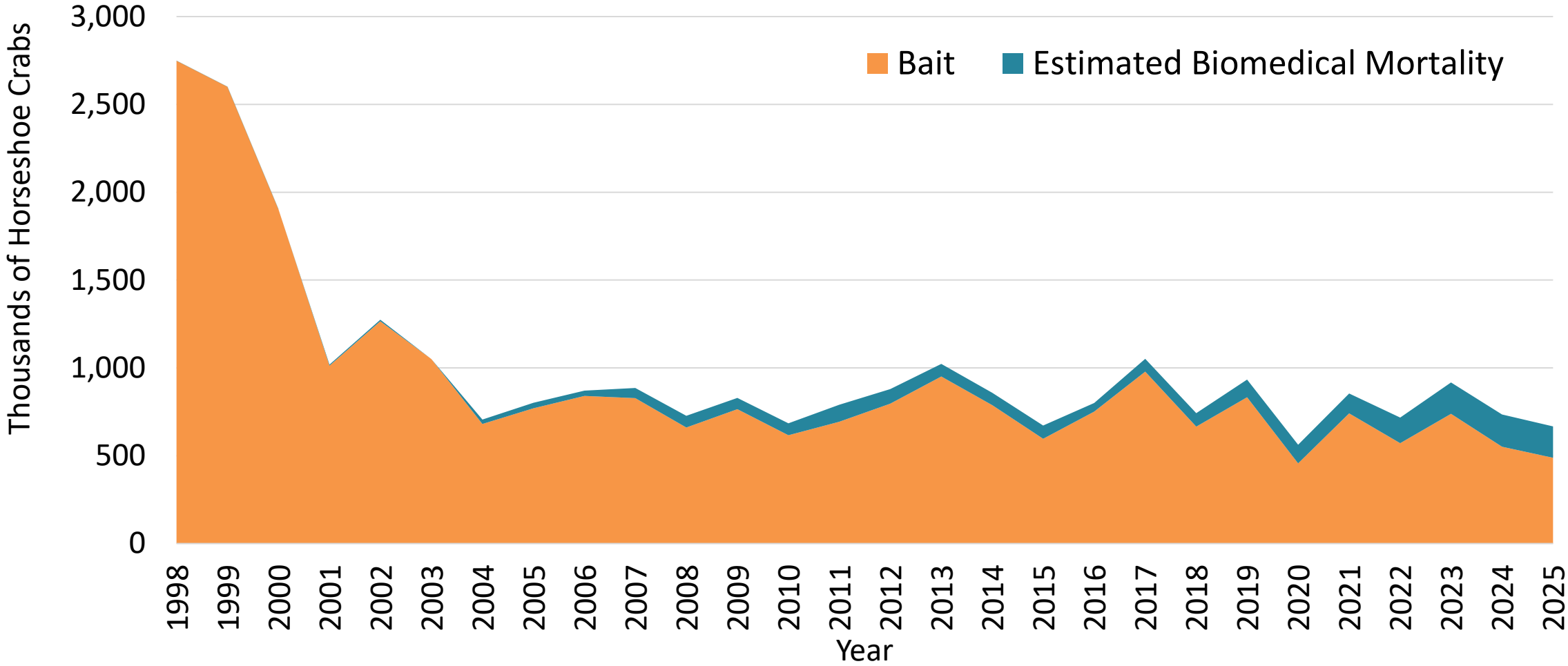
Biomedical Fishery

- Biomedical-only crabs collected in 2025: 1,031,504 crabs
  - 3.8% decrease from 2024 (1,073,329 crabs)
  - 56% male, 44% female
- Biomedical-only mortality estimate: 177,777 crabs
  - Biomed Mortality = 15% x # Biomed-Only Bled + # Observed Dead Before Bleeding
  - 26.6% of total directed removals; biomedical mortality + bait harvest (666,664 crabs)
- Total removals decreased by 9% from 2024

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Total Mortality

Total Horseshoe Crab Mortality (Bait and Biomedical) 1998-2025
Source: State Compliance Reports, 2026



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Compliance Review

- All states and jurisdictions appear in compliance with FMP provisions
  - MA did not meet compliance report deadline
- NY “Horseshoe Crab Protection Act” establishes a three-year phase-out of commercial and biomedical take of horseshoe crabs in state waters
  - Full moratorium in 2029

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De Minimis Requests

- Combined average bait landings (by numbers) for last two years < 1% of coastwide bait landings for the same two-year period
- SC, GA, and FL requested and qualify for *de minimis* status

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PRT Recommendations

- Continue seeking long-term funding for VT trawl survey
- Consider annual characterization of discard removals
- State compliance reports should identify biomedical companies collecting crabs and operating LAL manufacturing facilities in their jurisdiction, and report biomedical numbers by company

Atlantic States Marine Fisheries COMMISSION

Board Action for Consideration

- Consider approval of the FMP Review and state compliance reports for the 2025 fishing year, and *de minimis* status for SC, GA, and FL.

Questions?

