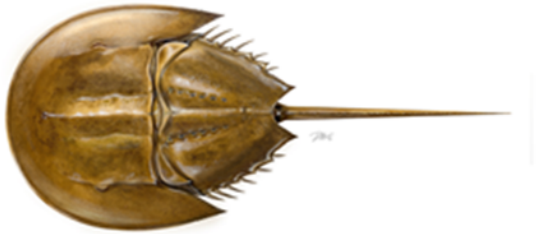
Horseshoe Crab
Adaptive Resource Management (ARM)
Review Recommendations



ASMFC Horseshoe Crab
Management Board
August 2nd,2016

Background

Addendum VII (2012)

- Established management program for Delaware Bay Region (NJ, DE, MD, and VA)
- Multispecies models (horseshoe crabs & red knots) to predict optimal strategy for horseshoe crab harvest
  - VT Trawl Survey (HSC) & Mark-resight (red knots)
- 2 Phase Approach-1) Set up phase and 2) Iterative phase

Background (cont.)

Addendum VII (2012)

- Harvest specifications for 2013-2016
  - 500 K crabs, male only
- Mortality estimates in the horseshoe crab population dynamics model
  - Natural mortality + harvest package mort.
- Fall 2015
  - TCs and ARM Subcommittee recommend reviewing the ARM Framework

Background (cont.)

- November 2015
  - Board requested that the ARM Subcommittee develop specific recommendations on changes to the ARM Framework
- February 2016
  - ARM Subcommittee presents 5 potential ARM review items to Board
  - Board tasked the ARM Subcommittee with 3 short-term review items (longer-term items not addressed)
- Three components involved in the short-term review
  1. Monitoring Program
  2. Harvest Packages
  3. Objective Function for decision making

1. Evaluate the Monitoring Program

- A. The Virginia Tech Bottom Trawl Survey
  - Primary monitoring effort that supports the ARM
  - Conducted from 2002-2012, but was reduced in 2012 and not funded in 2013-2015

Recommendation: To continue the Virginia Tech Bottom Trawl Survey in future years since it supports the ARM model and provides substantial data to the assessment.

Additionally, the group supports the recommendations from the 2009 Horseshoe Crab Stock Assessment to estimate the proportion of the Delaware Bay population that is available in time and space within the survey area and to continue the work to assess the selectivity of gear used in the survey.

1. Evaluate the Monitoring Program

- B. <u>Abundance indices from other surveys</u>
  - **DE** 16’ and 30’ trawl surveys, the **NJ** Delaware Bay trawl survey, the **NJ** Surf Clam dredge survey, and the **MD** Coastal Bays trawl survey
  - Previously developed a composite index from correlated indices to support missing years in VT Trawl Survey

Recommendation: If the VA Tech trawl survey is not funded beyond 2016, a practical alternative is to continue to use the composite index of abundance based on data from other trawl surveys.

1. Evaluate the Monitoring Program

- C. <u>Mark-recapture HSC Abundance Estimation</u>
  - Reviewed intensive tagging & simulation studies (Smith et al. 2006; Merritt 2015) to estimate population abundances
  - More work is needed on this model and estimation techniques before it can be used for management

Recommendation: At this time, mark-recapture is not a viable option for estimating horseshoe crab abundance within the ARM Framework and therefore it should not be incorporated into the model but it should continue to be developed for future consideration

1. Evaluate the Monitoring Program

- D. Red Knot (REKN) Population Monitoring Program
  - REKN mark-resight study design and sampling plan were reviewed by REKN monitoring teams and presented to the ARM committee; no new protocols implemented but renewed efforts to collect data
  - ARM uses mark-resight estimates which are larger than the aerial surveys
  - Disagreement among ARM members to the discrepancy between aerial survey and mark-resight estimates

Recommendation: Continue the mark-resight data collection program with renewed effort to collect data according to sampling plan.

1. Evaluate the Monitoring Program

E. Incorporation of Biomedical Data into the ARM Framework

- Previously not in ARM Framework
  - Biomedical accounts for 8-12% of coastwide mortality

- Developed and evaluated 5 options for accounting for biomedical mortality

Recommendation: Biomedical mortality should be accounted for in the ARM Framework.

- Putting forth a majority and minority option for Board consideration

1. E. Biomedical Options

Majority Option: Adjust harvest packages to account for biomedical mortality of females

- Harvest packages would be adjusted for biomedical mortality (while maintaining confidentiality)
  - Creates an allocation decision for the Board for biomed mortality and bait
- Change Harvest Packages every 4-6 years

Current Harvest Packages			Majority Option: Example Harvest Packages					
	Total Harvest		Total Harvest		Example Biomedical		Example Bait Harvest	
Package	Males	Females	Males	Females	Males	Females	Males	Females
1	0	0	36,000	18,000	36,000	18,000	0	0
2	250 K	0	250,000	18,000	36,000	18,000	214,000	0
3	500 K	0	500,000	18,000	36,000	18,000	464,000	0
4	280 K	140 K	280,000	140,000	36,000	18,000	244,000	122,000
5	420 K	210 K	420,000	210,000	36,000	18,000	384,000	192,000

1. E. Biomedical Options

Minority Option: Account for biomedical harvest in the population dynamics equations only of the ARM framework

- Does not create new harvest packages or change bait allocation
- Incorporate the biomedical mortality into the population dynamics equations only
  - Biomedical mortality as additional mortality factor to current harvest packages
- Issue: mortality associated with bled crabs is variable, not fixed like it would be in the model, but could potentially update this value every 4-6 years

2. Alternative Harvest Packages

- In recent years, harvest package #3 has been selected (500 K male, 0 female) while there has been a combined quota of 661 K crabs for the DB available under the FMP
- Evaluated several alternative harvest packages
- Adding/changing additional packages would not necessarily result in different selections since selection relies on current thresholds for female crab & red knot abundances

Recommendation: The ARM Subcommittee does not recommend adding new harvest packages to the ARM framework in this review item, although packages should be altered to address biomedical harvest.

3. Revisit the Objective Function

- A. Change the order of red knots and HSC in the objective statement

> *Manage harvest of horseshoe crabs in the Delaware Bay to maximize harvest but also to maintain ecosystem integrity and provide adequate stopover habitat for migrating shorebirds.*

  - Developed carefully with HSC & shorebird TCs, changing would be beyond the scope of this review

Recommendation: Changing the order of red knots and horseshoe crabs in the objective statement is not recommended.

3. Revisit the Objective Function

- <u>B. Evaluate the (2x) multiplier of utility of female crab harvest in the reward function</u>
  - This was put in the model to reflect that the market values F twice as much as M
  - This is still accurate in the DB market

Recommendation: Because the (2x) multiplier of utility of female crab harvest in the reward function reflects the market value of female crabs over males, it is recommended that this be left in the model.

3. Revisit the Objective Function

- C. Evaluate the sex ratio constraint on utility of male crabs
  - Possibly redundant with population dynamics model
  - Removing it resulted in only minor changes to the output of the model

Recommendation: The ARM Subcommittee is recommending the removal of the sex ratio constraint because it is conceptually redundant with aspects of the horseshoe crab population dynamics model.

3. Revisit the Objective Function

- <u>D. Evaluate the utility functions for female harvest (knife-edge vs. slope)</u>
  - Reviewed the work by Smith et al.
  - Sloped function did not demonstrate a significant difference from current knife-edge function
    - Very little change in population trajectory
  - No biological reasoning for change to utility function

Recommendation: Given the lack of change between the two approaches and lack of reasons to change the current approach, the group recommends no change from current knife-edge function

Next Steps

Next Steps

- If Board supports the majority opinion for the incorporation of biomedical data into the ARM, the an addendum will be needed to incorporate harvest packages
  - There would be public comment (approx. 30 days), public hearings, and additional call for TC & AP to provide comment
- All other changes to the model can be made and input data can be updated for 2017 fishing season

Questions and Comments

1. E. Biomedical Options

1. Include biomedical in the harvest allocation of horseshoe crabs within the Delaware Bay region

- Management Board specify a limit on mortality attributed to biomedical bleeding based
- Ex. Board allows 10.8% of harvest to biomedical mortality

Current Harvest Packages			Option 1 Harvest Packages			
Harvest Package	Bait Harvest		Bait Harvest		Biomedical Mortality	
	Males	Females	Males	Females	Males	Females
1	0	0	0	0	0	0
2	250,000	0	223,000	0	27,000	0
3	500,000	0	446,000	0	54,000	0
4	280,000	140,000	249,760	124,880	30,240	15,120
5	420,000	210,000	374,640	187,320	45,360	22,680

- Issue: recommending male only harvest for the biomedical could result in more mortality

1. E. Biomedical Options

3. Adjust harvest packages to add biomedical to the existing bait allocations

- Harvest packages adjusted to have explicit amounts allowed for bait and biomedical bleeding based on recent averages
- Ex. Average biomedical harvest over 3 years and add to current packages

Current Harvest Packages			Option 3 Harvest Packages					
Harvest Package	Bait Harvest		Bait Harvest		Biomedical Mortality		Total Harvest	
	Males	Females	Males	Females	Males	Females	Males	Females
1	0	0	0	0	0	0	0	0
2	250,000	0	250,000	0	36,000	18,000	286,000	18,000
3	500,000	0	500,000	0	36,000	18,000	536,000	18,000
4	280,000	140,000	280,000	140,000	36,000	18,000	316,000	158,000
5	420,000	210,000	420,000	210,000	36,000	18,000	456,000	228,000

1. E. Biomedical Options

5. Adjust harvest packages to account for biomedical mortality of females (2:1 male to female offset)

- Creates an allocation decision for the Board for biomed mortality and bait
  - Harvest packages adjusted for female biomedical mortality
- Harvest package changes could be done 4-6 year basis
- Ex. (2:1 male to female offset)

Current Harvest Packages			Option 5 Harvest Packages			
Harvest Package	Bait Harvest		Bait Harvest		Biomedical Mortality	
	Males	Females	Males	Females	Males	Females
1	0	0	0	0	0	0
2	250,000	0	178,000	0	72,000	0
3	500,000	0	428,000	0	72,000	0
4	280,000	140,000	244,000	122,000	36,000	18,000
5	420,000	210,000	384,000	192,000	36,000	18,000

1. E. Biomedical Options

Majority Option: Adjust harvest packages to account for biomedical mortality of females

- Creates an allocation decision for the Board for biomed mortality and bait
  - Harvest packages would be adjusted for female biomedical mortality (maintaining confidentiality)
- Change Harvest Packages every 4-6 years

Current Harvest Packages			**Majority Option: <u>Example</u> Harvest Packages**					
	Total Harvest		Total Harvest		Bait Harvest		Example Biomedical	
Package	Males	Females	Males	Females	Males	Females	Males	Females
1	0	0	36,000	18,000	0	0	36,000	18,000
2	250,000	0	250,000	18,000	214,000	0	36,000	18,000
3	500,000	0	500,000	18,000	464,000	0	36,000	18,000
4	280,000	140,000	280,000	140,000	244,000	122,000	36,000	18,000
5	420,000	210,000	420,000	210,000	384,000	192,000	36,000	18,000

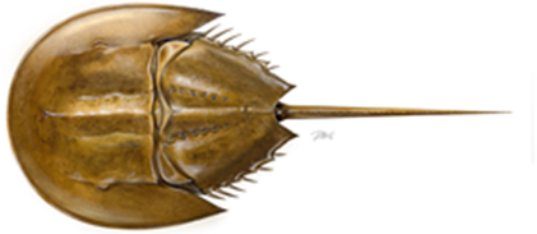
1. E. Biomedical Options

Majority opinion: Adjust harvest packages to account for biomedical mortality of females

- Creates an allocation decision for the Board for biomed mortality and bait
  - Harvest packages would be adjusted for female biomedical mortality
- Harvest package changes could be done 4-6 year basis

Current Harvest Packages			Option 4 Harvest Packages			
Harvest Package	Bait Harvest		Bait Harvest		Biomedical Mortality	
	Males	Females	Males	Females	Males	Females
1	0	0	0	0	36,000	18,000
2	250,000	0	214,000	0	36,000	18,000
3	500,000	0	464,000	0	36,000	18,000
4	280,000	140,000	244,000	122,000	36,000	18,000
5	420,000	210,000	384,000	192,000	36,000	18,000

ASMFC Horseshoe Crab TC & Delaware Bay Ecosystem TC Review of



Adaptive Resource Management (ARM) Subcommittee Recommendations

Horseshoe Crab Management Board
August 2nd, 2016

Introduction

- Horseshoe Crab TC and Delaware Bay Ecosystem TC met via conference call on July 28th
- ASMFC Staff presented the ARM Subcommittee review & recommendations
- Evaluated the ARM Subcommittee recommendations
  - Considered the biomedical mortality estimate inclusion
- Discussed biomedical mortality threshold exceedance

ARM Model Review

- The TCs were in agreement that the ARM Subcommittee review was acceptable.
- Comments included:
  - Further exploration of alternative harvest packages with female harvest
  - Further work be done to reconcile red knot mark-resight abundance estimates with aerial estimates

Biomedical mortality in ARM Framework

Both TCs agreed that the ARM Framework should incorporate biomedical mortality

- A majority of both TCs were in favor of the ARM Subcommittee's preferred option. Reasons cited:
  - Does not violate confidentiality rules
  - Transparent and explicit of mortality estimate
  - Treats harvest types (bait and biomedical) similar
- Minority support for the ARM Subcommittee's secondary option. Reasons cited:
  - account for biomedical mortality without changing harvest packages
  - Would not require an addendum
  - Transparent inclusion in the ARM Framework

Biomedical mortality in ARM Framework cont'd.

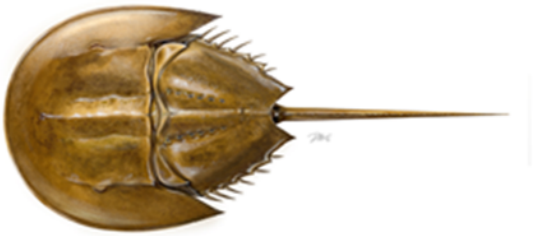
- Other comments
  - If addendum is developed, sensitivity analysis should be done to see how different both options would be if implemented.
  - Consider applying a small buffer to biomedical allocation to allow variances in increases in harvest/industry growth.
  - Confusion over jurisdiction and ability of Board to limit biomedical harvest
    - Rhode Island does, no other states do currently
- Both TCs request the Board determine jurisdiction for possibility of limiting biomedical collection and harvest

Biomedical threshold exceedance recommendations

- TCs were in agreement with recommendations
  - Some TC members suggested requiring biomedical companies to contribute funding to VT trawl survey and other studies on biomedical mortality

Questions ?

ASMFC Horseshoe Crab AP Review of



Adaptive Resource Management (ARM) Subcommittee Recommendations

Horseshoe Crab Management Board
August 2nd, 2016

Introduction

- Horseshoe Crab AP met via conference call on July 28th
- ASMFC Staff presented the ARM Subcommittee review & recommendations
- Evaluated the ARM Subcommittee recommendations
  - Considered the biomedical mortality estimate inclusion
- Discussed biomedical mortality threshold exceedance

ARM Model Review

- The AP found the recommendations of the ARM Subcommittee were not substantive.
- The AP disagreed with the ARM Subcommittee's recommendation to include biomedical mortality in the ARM Framework.
- Reasons cited:
  - Concern over including an incorrect number of facilities in the Delaware Bay region and inaccuracies in the mortality estimates associated with bleeding activities.
  - The preferred option would bring the two industries- the bait fishery and biomedical - into direct conflict with each over.
  - Bait fishery should not harvest allocation reduced due to biomedical activities.

Biomedical mortality cont'd.

Reasons cited continued:

- Mortality estimates from bleeding horseshoe crabs are insignificant relative to the bait fishery harvest.
- Including biomedical data in the ARM models would go against the intention of the ARM Framework as outlined in Addendum VII.
- Concern that neither the preferred option nor the secondary option have been tested through simulations by the ARM Subcommittee and are therefore not ready for the Board to consider.
- Concern that including biomedical data in the ARM Framework would be the first step in limiting the production of Limulus amebocyte lysate (LAL).

Biomedical mortality cont'd.

Reasons cited continued:

- Limiting the production of LAL would have significant impacts to both the biomedical community and the broader US Health system.

- The AP has not been provided enough time to comment on recommendations ahead of the ASMFC Summer Board meeting in August 2016.

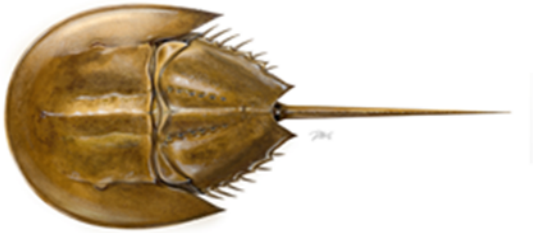
- The AP, and more specifically the Biomedical Industry, was not consulted by the ARM Subcommittee in the development of options for including biomedical data in the ARM Framework.

Biomedical threshold exceedance recommendations

- The AP took exception with most of the 5 recommendations
  - The AP was in agreement with the ARM Subcommittee that the 2011 Biomedical handling BMPs should be revisited over the next 2 years.

Questions ?

Follow Up Discussion on additional Horseshoe Crab Bait Trials



Horseshoe Crab Management Board
August 2nd, 2016

Background

- **February 2016**: Board presented the results of 2014 alternative horseshoe crab bait trials conducted in CT and Rhode Island.
  - Based on the results of the trials, the Board tasked staff with developing a cost3 comparison.
- **May 2016**: Board presented considerations by the TC and AP in developing a cost comparison of different bait types and considering additional bait trials.
- **July 2016**: the Board was presented a prospectus for conducting additional bait trials in fall 2016.

Next Steps

- Consider specific goals and objectives of additional horseshoe crab alternative bait trials

- Consider tasking Technical Committee with conducting additional bait trials
  - Specify fishery, bait type, states, and time of year

Questions ?