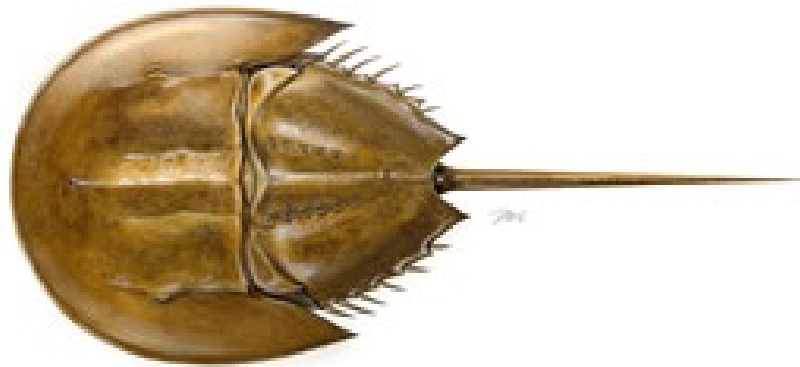


# Recommended updates for the Delaware Bay HSC ARM model



## Presentation to the HSC Management Board

*October 29, 2019*

# Joint DBETC & ARM SC Meeting



September 11 – 12, 2019

**Purpose:** Develop recommendations to the HSC Management Board for the ARM following the 2019 HSC Benchmark Stock assessment

6 Consensus Recommendations

# Recommendation #1



## Background:

- VA Tech survey is conducted in the fall; Red Knot abundance estimated in the spring
- Both primiparous and multiparous crabs that survive from the fall to the spring will spawn and represent the number of crabs that can provide eggs to shorebirds
- A better estimate of the number of crabs producing eggs during the shorebird stopover would decrement the abundance of HSC estimated in the fall by ½ year mortality.
- $\text{Crabs}_{\text{spring}} = (\text{Primiparous}_{\text{fall}} + \text{Multiparous}_{\text{fall}}) \cdot \exp(-0.274/2)$

# Recommendation #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.**

# Recommendation #2



## Background:

- 10+ years since we developed the underlying HSC population dynamics model
  - Sweka et al. age-structured model published in 2007
  - Converted to a stage-structured model in 2008
  - ARM peer-reviewed in 2009
- We know more now!
  - More years of data
  - New mortality estimates
  - Dead discard estimates
  - Peer-reviewed and approved stock assessment model (CMSA)

# Recommendation #2



Revised HSC model:

$$N_i = [(N_{i-1} + R_{i-1})e^{(-M*t)} - C_{i-1}]e^{(-M*(1-t))}$$

N is simply a function of R, M, and C

N = previously mature animals = multiparous crabs

R = newly mature animals = recruits = primiparous crabs

Assessed in the fall by VA Tech trawl and both will spawn the following spring

C = catch = removals from all sources (bait + biomedical + discards)

\*\*Need to produce R's in the projection model  
– Assumed stock-recruit relationship

# Recommendation #2



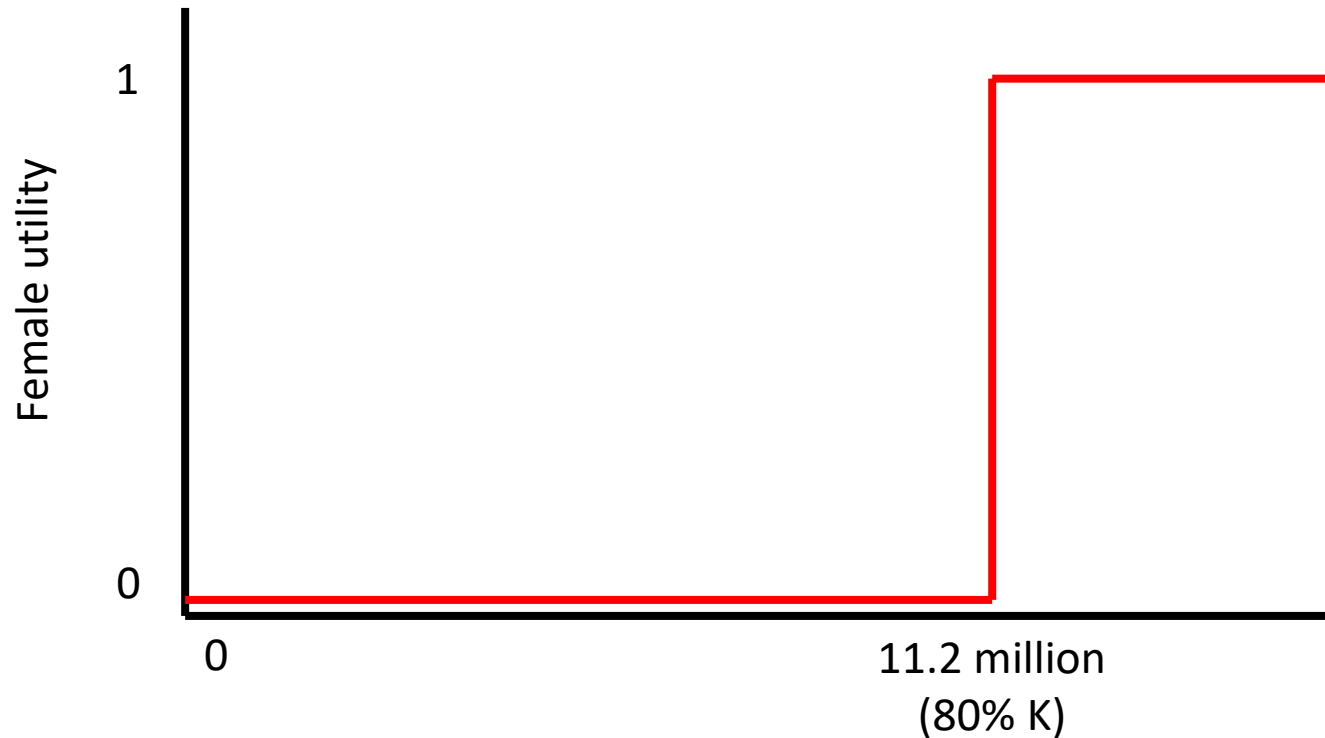
## Advantages:

- Empirical – driven by observed data; less emphasis on literature values for life history parameters (e.g., adult M, removals)
- No need to make assumptions about juvenile stages of crabs
- Observed data provide immediate feedback and model adjustment
- Assessment model and projection model are contained within the same modeling framework (criticism by peer-reviewers on previous models)
- USGS funded position for transitioning from ASDP to MDPSOLVE in 2020 - 2021 (ASMFC staff will be able to run the model)

# Recommendation #2



## Current Female HSC Utility Function



- K might change given the new underlying HSC population dynamics model
- Is some proportion of K a suitable threshold?



# Recommendation #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.**

# Recommendation #3



## Background:

McGowan et al. (2011)

- Relationship between HSC abundance and RK mass gain and survival
- Used data from 1997 – 2008
- We have now doubled the amount of data available for this analysis

# Recommendation #3



## Background:

### 3 HSC/RK models

- HSC do not limit Red Knots (current weight = 0.2)
- HSC limit Red Knot fecundity (current weight = 0.4)
- HSC limit Red Knot fecundity and survival (current weight = 0.4)

# Recommendation #3



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

# Recommendation #4



## Background:

- Previously tasked with options to incorporate biomedical mortality into the current ARM framework.
- By moving to the CMSA as the assessment model, biomedical mortality is accounted for in the population estimation. Biomedical mortality is model input.
- Also modeled in the projections of the CMSA when making optimum bait harvest recommendations.
- CMSA use does not alter harvest packages, so it does not require an addendum (i.e., postponed draft Add. VIII)

# Recommendation #4



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

# Recommendation #5



## Background:

- Data confidentiality issue – Rule of 3
- Annual population estimates from the CMSA could be used to back calculate biomedical mortality in the DE Bay
- “Black box” assessment with real data vs. Non-confidential data assessment that is less accurate

# Recommendation #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.**



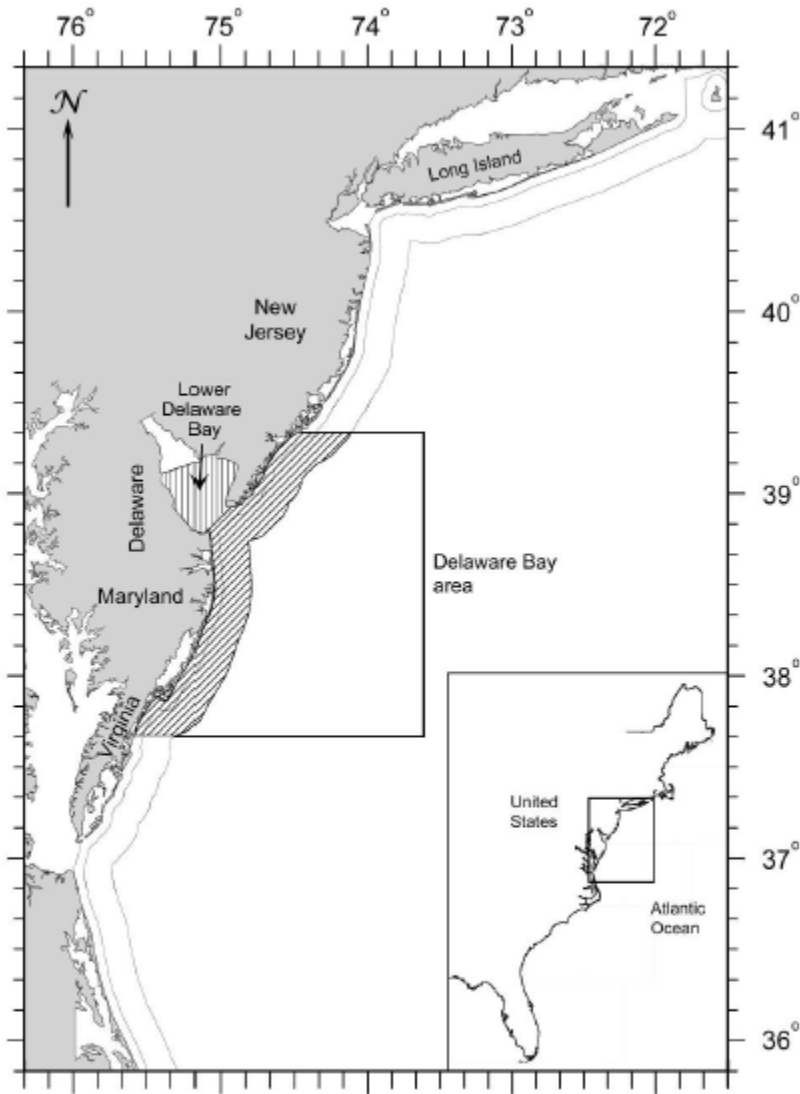
# Recommendation #6



## Background:

- What is a Delaware Bay crab?
- Working definition has been “a crab that could spawn in DE Bay at some point in it’s life”

# Recommendation #6



VA Tech Crabs - Can spawn in DE Bay sometime during their lives

Crabs in MD waters

Crabs in VA waters

# Recommendation #6



## Background:

- Harvest allocation under Addendum VII was based on genetic information available at that time
- New genetic information
- New tagging analysis quantifying movement rates

# Recommendation #6



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

# Recommendations



- 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).**

# Recommendations



**5. First, request the disclosure of confidential biomedical data for use 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.**

# Recommendation Implementation



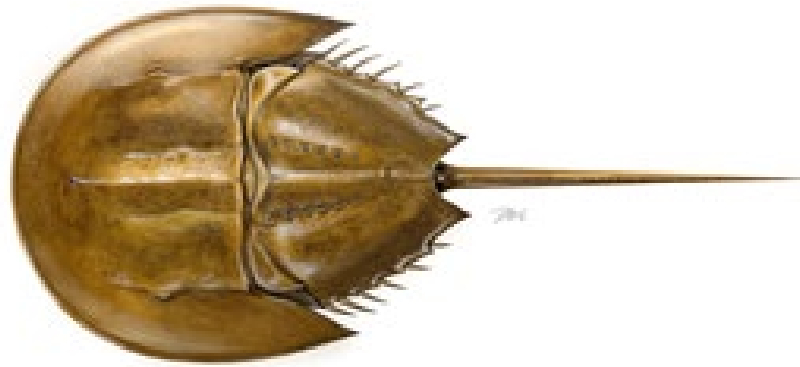
- Formal charge by the Mgt. Board to the ARM workgroup to incorporate recommendations
- Several in person meetings or webinars (maybe not the entire ARM workgroup)
- Have a funded USGS post-doc position for model coding – fully moving forward by March 2020 and completed by end of 2021.
- Presentation to DE Bay TC
- External peer review
- Presentation to the Mgt. Board and approval for management use
- ~2 year time frame before implementation for management use
- Current ARM framework continues until then

A large, reddish-brown horseshoe crab is shown on a sandy beach. The crab is positioned in the center of the frame, facing towards the right. Its body is a deep, glossy reddish-brown color, and it has a prominent, rounded carapace. The background is a light-colored, textured sand. The word "Questions?" is overlaid in black text on the crab's body.

Questions?



# Consideration of Reinitiating Postponed Draft Addendum VIII



## Management Board Meeting

*October 2019*

# Draft Addendum Timeline



- August 2016
  - *Move to initiate an addendum to the HSC management plan to address the ARM Subcommittee's recommendation to the ARM framework regarding*
    - 1) *mortality associated with the biomedical industry; and*
    - 2) *bait harvest packages which allow female horseshoe crab harvest as presented in Appendix C of the framework review.*

# Draft Addendum Timeline



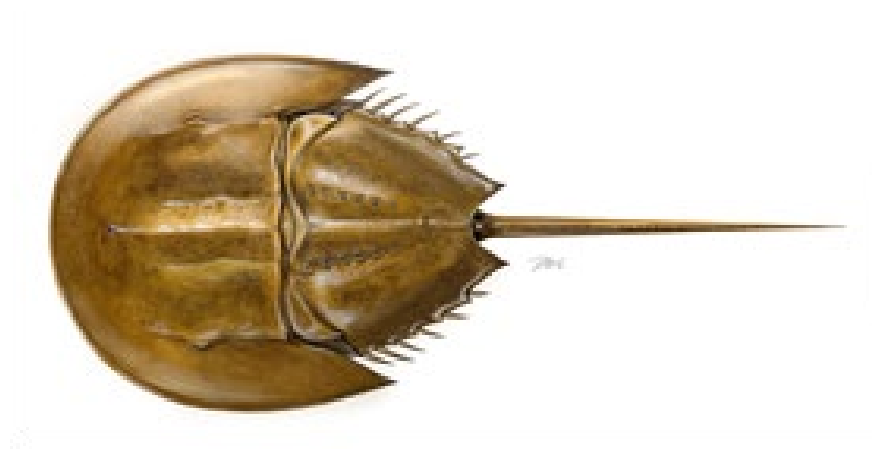
- October 2016
  - *Move to postpone development of Draft Addendum VIII until after the [2019] Benchmark Stock Assessment has been completed for Delaware Bay*
- October 2017
  - ARM sensitivity runs conducted on 2 biomedical mortality inclusion options; showed minimal impact of biomedical mortality on HP selection for either
  - Clarification of ARM female HSC utility function: unless HSC females or red knots exceed threshold, no female harvest selected by model

# Draft Addendum Timeline



- May 2019
  - Benchmark Stock Assessment completed; showed no significant impact of biomedical mortality on DE Bay females
  - Board tasked ARM SC with incorporating CMSA estimates into ARM Framework
- October 2019
  - ARM SC and DBE TC recommendations include incorporation of biomedical mortality without addendum
  - To resume development of Draft Add VIII: Direct staff
  - To not resume development of Draft Add VIII: Action

# 2020 Harvest Specifications for the Delaware Bay



# Adaptive Resource Management (ARM)



*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*

- Red knot and HSC population thresholds
- Red knot and HSC abundance estimates
- 5 harvest packages
- Harvest recommendations

# Harvest Packages



- 5 harvest policies range from full moratorium to a max harvest of 420,000 males and 210,000 females, including two male only harvest options

Harvest package	Male harvest ( 1,000)	Female harvest ( 1,000)
1	0	0
2	250	0
3	500	0
4	280	140
5	420	210

# Thresholds in ARM



## 1. Population thresholds



### Female HSC:

80% carrying capacity  
(or 11.2 million F crabs)



### Red knot:

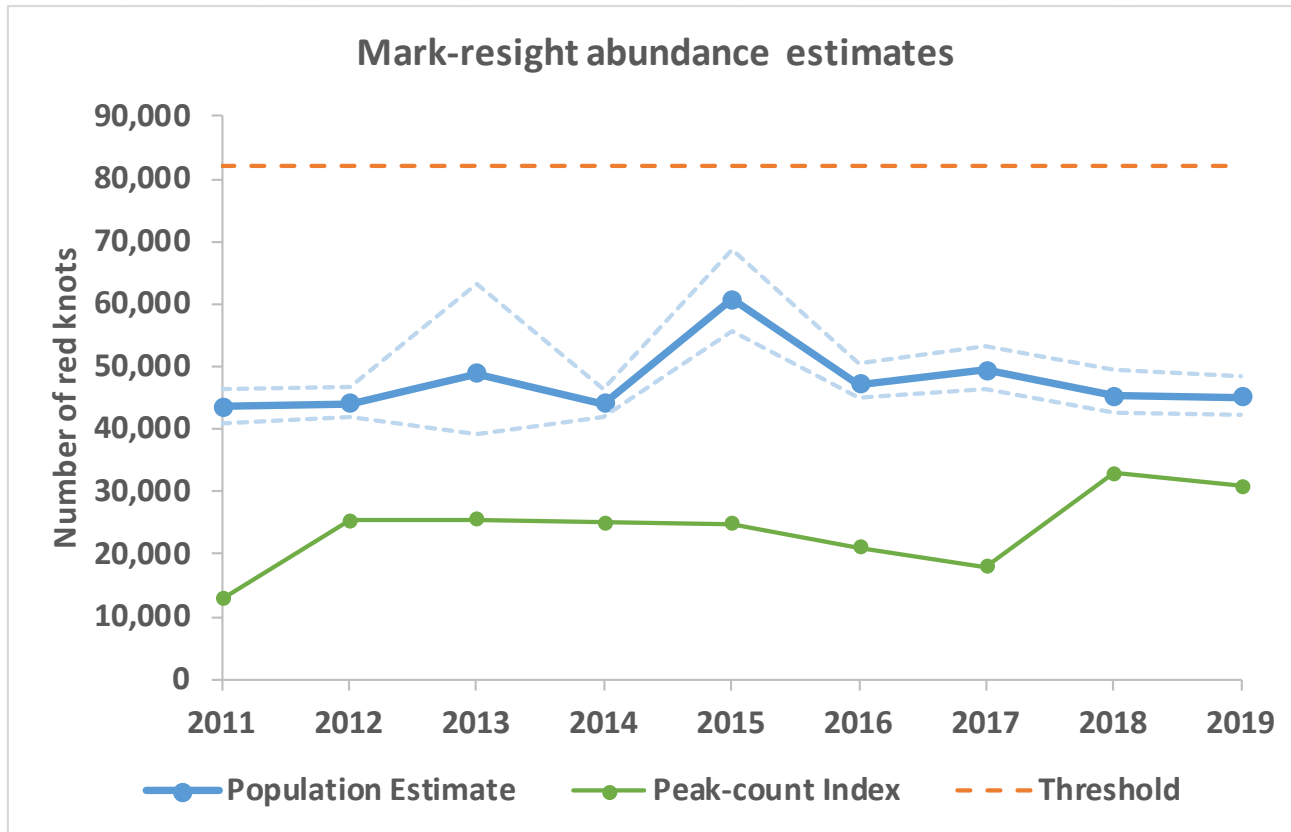
81,900 birds

## 2. Maintain a spawning beach sex ratio of 2M:1F

- If both population estimates are below threshold, *no female HSC harvest*
- If sex ratio falls below 2M:1F, *no male HSC harvest*



# Red Knot Abundance



- Red knot abundance from mark-resight investigations
- 2019 estimates are similar to 2016-2018
- 2019 estimated stopover duration was 12.1 days, greater than 2018 estimate of 9.7 days
- 2019 estimate of 45,133 is below threshold of 81,900 birds

# Horseshoe Crab Abundance



- HSC abundance estimates are based on VT trawl survey
- VT trawl survey not funded every year, so **composite index** was developed
  - Uses DE 30' trawl, NJ DB trawl, and NJ ocean trawl surveys
- 2018 estimate of 7.9 million females is under the 11.2 threshold
- 2018 had 7.9 million females, 16.6 million males

- **Composite index values for 2013 - 2015**

# 2020 Harvest Recommendation



## HSC and red knot abundance estimates:

Horseshoe crab abundance (millions)			Red knot abundance ( 1,000)	
Year	Male	Female	Year	Male and female
2018 (Fall)	16.6	7.9	2019 (Spring)	45.13

## Harvest package recommendation:

Recommended harvest package	Male harvest ( 1,000)	Female harvest ( 1,000)
3	500	0

- Both red knots and female HSC are below threshold, therefore no female harvest is recommended

# 2020 Harvest Recommendation



State	Delaware Bay Origin HSC Quota		Total Quota	
	Male	Female	Male	Female
Delaware	162,136	0	162,136	0
New Jersey	162,136	0	162,136	0
Maryland	141,112	0	255,980	0
Virginia	34,615	0	81,331	0

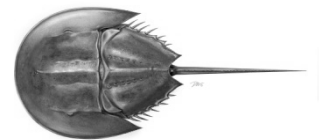
A large, reddish-brown horseshoe crab is shown on a sandy beach. The crab is positioned in the center of the frame, facing towards the right. Its body is a deep, glossy reddish-brown color, and it has a prominent, rounded carapace. The background is a light-colored, textured sand. The word "Questions?" is overlaid in the center of the image in a large, black, sans-serif font.

Questions?



# **Horseshoe Crab 2019 FMP Review**

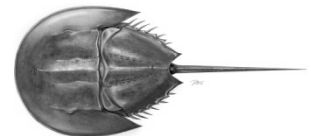
**Horseshoe Crab Management Board  
October, 2019**



# Management History



- **FMP Approved (1998)**
- **Addendum I (2000)** – State bait harvest quotas and *de minimis*
- **Addendum II (2001)** – Quota transfers
- **Addendum III (2004)** – DE Bay state bait quotas and seasonal closures
- **Addendum IV (2006)** – DE Bay state bait quotas and seasons
- **Addendum V (2008)** – Extension of Add IV
- **Addendum VI (2010)** – Extension of Add V
- **Addendum VII (2012)** – DE Bay ARM Framework

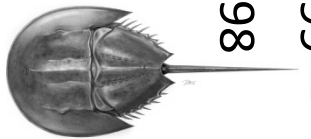
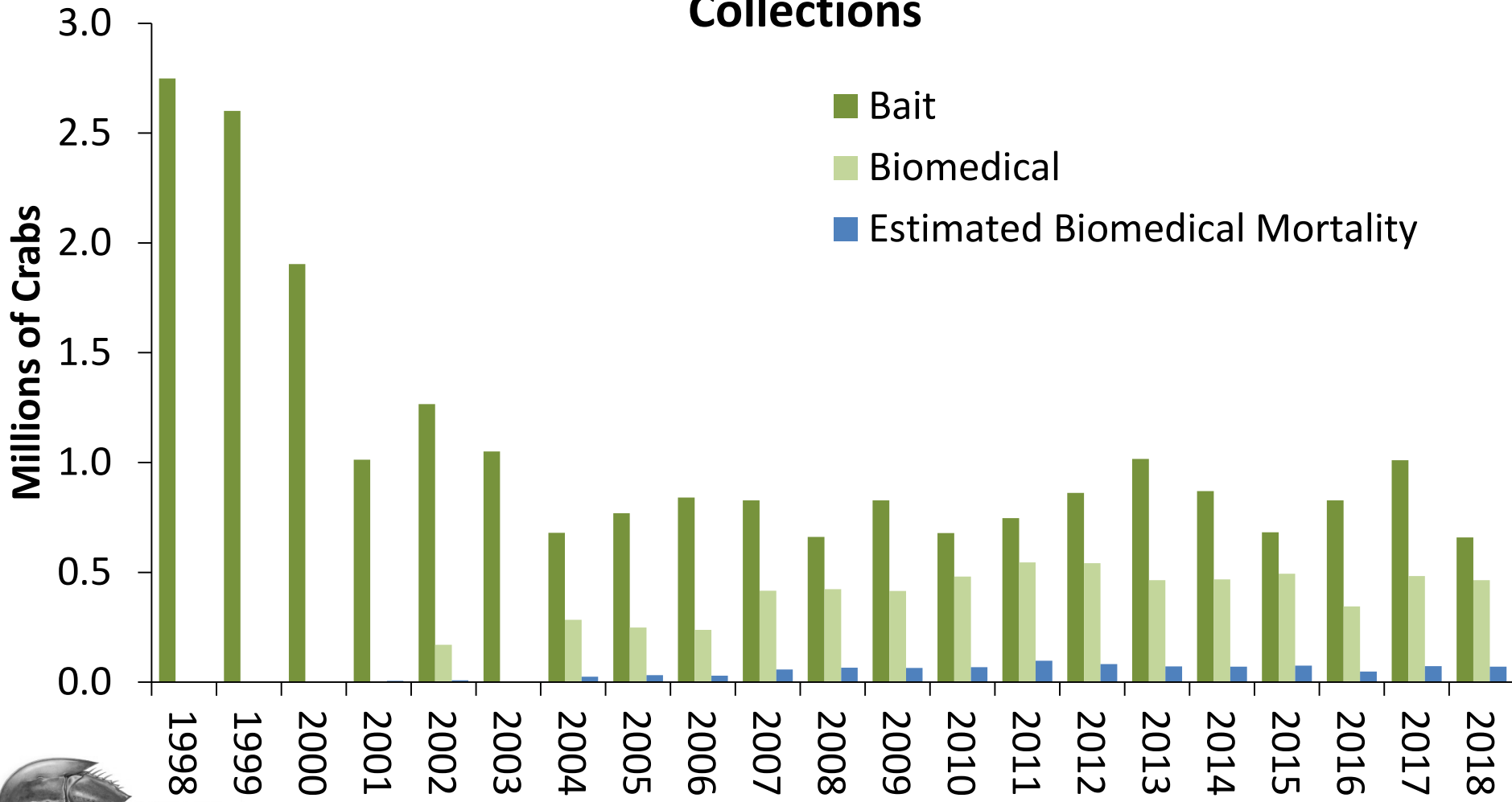


Descriptions in Section I of FMP Review

# Annual Total Harvest



## Coastwide Horseshoe Crab Bait Landings & Biomedical Collections

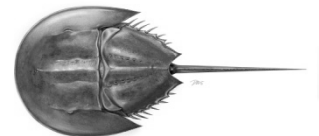




# 2018 Bait Fishery



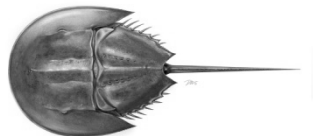
- Total coastwide harvest was 658,589 crabs
  - Majority from MA, VA, and NY (combined for 66% of coastwide harvest)
- 35% decrease from 2017
- Approximately 41% of the coastwide quota (1.59 million lbs) was landed
- DE overage of reduced quota: 2,925 crabs (reduced quota for 2019)



# Biomedical Use



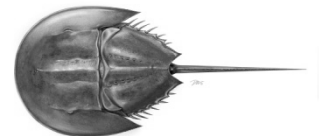
- Biomedical-only crabs collected: 464,482
  - 4% decrease from 2017
- Biomedical-only mortality estimate: 70,881
  - Biomed Mortality = Reported # Observed Dead Before Bleeding + 15% x Reported # Biomed-Only Bled
  - 10% of directed removals; biomedical mortality + bait harvest (658,589 crabs)



# De Minimis



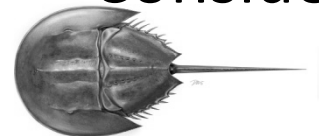
- Combined average bait landings (by numbers) for last two years less than 1% of coastwide bait landings for the same two-year period
- PRFC, SC, GA, and FL all requested and qualify for *de minimis* status for 2019
- NJ qualified but did not request



# PRT Recommendations



- Continue seeking long-term funding for VT trawl survey
  - Funded through 2020
- Consider changing compliance report due date to July 1
- Approve the 2019 FMP Review, state compliance reports, and *de minimis* status for PRFC, SC, GA, and FL.
- Encourage and monitor actions to reverse negative population trends in NY region
- Biomed exceeded threshold, Board required to consider management action; assessment results do not indicate significant mortality from current biomedical use
- Consider annual characterization of discard removals



A large, reddish-brown horseshoe crab is shown resting on a sandy beach. The crab's body is a deep, glossy brown, and its legs are visible extending from the sides. The background is a light-colored, textured sand.

Questions?