Atlantic States Marine Fisheries Commission

Horseshoe Crab Management Board

October 26, 2016
8:00 – 10:00 a.m.
Bar Harbor, Maine

Draft Agenda

The times listed are approximate; the order in which these items will be taken is subject to change; other items may be added as necessary.

1. Welcome/Call to Order *(J. Gilmore)* 8:00 a.m.

2. Board Consent 8:00 a.m.
   - Approval of Agenda
   - Approval of Proceedings from August 2016

3. Public Comment 8:05 a.m.

4. Consider Comments from the ARM Subcommittee on Draft Addendum VIII (*K. Rootes-Murdy*) **Possible Action** 8:15 a.m.
   - ARM Subcommittee Report (*K. Anstead)*

5. Horseshoe Crab Technical Committees Report (S. *Doctor)* **Possible Action** 9:00 a.m.
   - Shorebird and Horseshoe Crab Survey Reports Summary
   - Adaptive Resource Management (ARM) Framework Harvest Output for 2017
   - Recommendations on Bait Trials

6. Set 2017 Delaware Bay Horseshoe Crab Fishery Specifications (*K. Rootes-Murdy*) **Final Action** 9:30 a.m.

7. Consider Approval of 2016 FMP Review and State Compliance (*K. Rootes-Murdy*) **Action** 9:45 a.m.

8. Other Business/Adjourn 10:00 a.m.

The meeting will be held at the Harborside Hotel, 55 West Street, Bar Harbor, Maine; 207.288.5033

MEETING OVERVIEW

Horseshoe Crab Management Board Meeting
Wednesday October 26, 2016
8:00 – 10:00 a.m.
Alexandria, Virginia

Chair: Jim Gilmore (NY) Assumed Chairmanship: 10/14	Horseshoe Crab Technical Committee Chair: Steve Doctor (MD)	Law Enforcement Committee Representative: Doug Messeck (DE)
Vice Chair: Dr. Malcolm Rhodes (SC)	Horseshoe Crab Advisory Panel Chair: Dr. Jim Cooper (SC)	Previous Board Meeting: August 2, 2016
Shorebird Advisory Panel Chair: Dr. Sarah Karpanty (VA)	Delaware Bay Ecosystem Technical Committee Chair: Greg Breese (FWS)	
Voting Members: MA, RI, CT, NY, NJ, DE, MD, DC, PRFC, VA, NC, SC, GA, FL, NMFS, USFWS (16 votes)		

2. Board Consent

- Approval of Agenda
- Approval of Proceedings from August 2, 2016 Board Meeting

3. Public Comment – At the beginning of the meeting public comment will be taken on items not on the agenda. Individuals that wish to speak at this time must sign-in at the beginning of the meeting. For agenda items that have already gone out for public hearing and/or have had a public comment period that has closed, the Board Chair may determine that additional public comment will not provide additional information. In this circumstance the Chair will not allow additional public comment on an issue. For agenda items that the public has not had a chance to provide input, the Board Chair may allow limited opportunity for comment. The Board Chair has the discretion to limit the number of speakers and/or the length of each comment.

4. Consider Comments from the ARM Subcommittee on Draft Addendum VIII (8:15 – 9:00 a.m.) Possible Action

Background

- At the 2016 Summer Meeting, the Board initiated a draft addendum that proposed changes to the Adaptive Resource Management (ARM) Framework that included accounting for mortality associated with biomedical bleeding activities as well as explore options that allow for the harvest of female horseshoe crabs.
- The ARM Subcommittee met in September 2016 to review updated information on horseshoe crab and red knot abundance and consider ARM model harvest output for 2017. Additionally, the ARM Subcommittee provided feedback on a request to conduct

analysis to better understand the impact of biomedical mortality on the ARM model harvest output. (**Briefing Materials**)

Presentations

- ARM Subcommittee Report by K. Anstead
- Challenges with developing Draft Addendum VIII by K. Rootes-Murdy

Board actions for consideration at this meeting

- Provide guidance on if and how draft addendum VIII should be developed at this time

5. Horseshoe Crab Technical Committees Report (9:00-9:30 a.m.) Possible Action

Background

- The Delaware Bay Ecosystem and Horseshoe Crab Technical Committees (TCs) jointly met on October 5, 2016.
- The TCs reviewed the updated horseshoe crab abundance information, considered the ARM harvest output, and discussed continuation of the alternative bait trials. (**Supplemental Materials**)

Presentations

- TCs Report by S. Doctor

Board actions for consideration at this meeting

- Provide guidance on if and how draft addendum VIII should be developed at this time

6. Set 2017 Delaware Bay Horseshoe Crab Fishery Specifications (9:30-9:45 a.m.) Final Action

Background

- The ARM subcommittee met by conference call in September 2016.
- In the absence of the Virginia Tech Trawl Survey data in recent years, the ARM Subcommittee considered a composite index to inform horseshoe crab abundance in the Delaware Bay region. Using updated abundance information on horseshoe crabs and Red Knots in the Delaware Bay region, the ARM Subcommittee made a recommendation on the 2017 harvest specifications for the Delaware Bay Region states.
- The Horseshoe Crab TCs reviewed and endorsed the ARM subcommittee harvest recommendation at their meeting in October 2016. (**Briefing Materials**)

Presentations

- Overview of the ARM harvest output by K. Rootes-Murdy

Board actions for consideration at this meeting

- Consider ARM harvest recommendations and set specifications for the Delaware Bay states in 2017.

7. Consider Approval of the 2016 FMP Review and State Compliance (9:45-10:00 a.m.) Action
Background • State Compliance Reports are due March 1. • The Plan Review Team reviewed each state report and drafted the annual FMP Review. (**Supplemental Materials**) • The Potomac River Fisheries Commission, South Carolina, Georgia, and Florida have requested and meet the requirements of *de minimis* status.
Presentations • Overview of the FMP Review by K. Rootes-Murdy
Board actions for consideration at this meeting • Accept 2016 FMP Review and State Compliance Reports. • Approve *de minimis* requests from the Potomac River Fisheries Commission, South Carolina, Georgia, and Florida.

8. Other Business/Adjourn

DRAFT PROCEEDINGS OF THE

ATLANTIC STATES MARINE FISHERIES COMMISSION

HORSESHOE CRAB MANAGEMENT BOARD

The Westin Alexandria
Alexandria, Virginia
August 3, 2016

These minutes are draft and subject to approval by the Horseshoe Crab Management Board
The Board will review the minutes during its next meeting

TABLE OF CONTENTS

INDEX OF MOTIONS

ATTENDANCE

Board Members

Bill Adler, MA (GA)
Sarah Ferrara, MA, proxy for Rep. Peake (LA)
Dan McKiernan, MA, proxy for D. Pierce (AA)
Bob Ballou, RI, proxy for J. Coit (AA)
D. Simpson, CT (AA)
Rep. Craig Miner, CT (LA)
Rep. Melissa Ziobron, CT Legislative proxy
James Gilmore, NY (AA)
Emerson Hasbrouck, NY (GA)
John McMurray, NY, proxy for Sen. Boyle (LA)
Brandon Muffley, NJ, proxy for D. Chanda (AA)
Tom Fote, NJ (GA)
Stewart Michels, DE, proxy for D. Saveikis (AA)
Craig Pugh, DE, proxy for Rep. Carson (LA)
Roy Miller, DE (GA)
David Blazer, MD (AA)
Rachel Dean, MD (GA)
Kyle Schick, VA, proxy for Sen. Stuart (LA)
Rob O'Reilly, VA, proxy for J. Bull (AA)
Michelle Duval, NC, proxy for B. Davis (AA)
Jerry Schill, NC, proxy for Rep. Steinburg (LA)
Robert Boyles, Jr., SC (AA)
Malcolm Rhodes, SC (GA)
Spud Woodward, GA (AA)
Pat Geer, GA, proxy for Rep. Nimmer (LA)
James Estes, FL, proxy for J. McCawley (AA)
Mike Millard, USFWS
Chris Wright, NMFS
Martin Gary, PRFC

(AA = Administrative Appointee; GA = Governor Appointee; LA = Legislative Appointee)

Ex-Officio Members

Steve Doctor, Technical Committee Chair
James Cooper, Advisory Panel Chair
Jim Lyons, ARM Subcommittee Chair

Staff

Robert Beal
Toni Kerns
Kristin Anstead
Kirby Rootes-Murdy

Guests

Dennis Abbott, NH Legislative proxy
Colleen Giannini, CT Administrative proxy
Sherry White, USFWS
Wilson Laney, USFWS
Debra Lambert, NOAA
Peter Aarrestad, CT DEEP
Justin David, CT DEEP
Cheri Patterson, NH F&H
Russ Allen, NJ DFW
Andrew Shiels, PA F&B Commission
Mike Luisi, MD DNR
Lewis Gillingham VA MRC
Jeff Deem, VMRC
Allen Burgenson, Lonza Walkersville, Inc.
Benjie Swan, Limuli Labs
Arnold Leo, E. Hampton, NY

The Horseshoe Crab Management Board of the Atlantic States Marine Fisheries Commission convened in the Edison Ballroom of the Westin Hotel, Alexandria, Virginia, August 2, 2016, and was called to order at 2:40 o'clock p.m. by Chairman James J. Gilmore.

CALL TO ORDER

CHAIRMAN JAMES J. GILMORE: Good afternoon everyone. Welcome to the Horseshoe Crab Board meeting. I've been instructed by Bob and Toni that I have to get us back on schedule or I'm not getting paid. We've got to really be efficient in our deliberations today. My name is Jim Gilmore; I'm the administrative commissioner from New York, and I'll be chairing the meeting today.

Just a couple of introductions before we go, we've got obviously Kirby Rootes-Murdy; who everyone knows from the commission staff, is doing a fine job running this whole thing. Jim Lyons, who doesn't have a name tag today is going to be doing presentations. We've got Steve Doctor from the Technical Committee, and we've got Jim Cooper; who is on the Advisory Panel. With that, we'll just get right into the agenda.

APPROVAL OF AGENDA

CHAIRMAN GILMORE: The first order of business is approval of the agenda; it should be in your briefing materials. Are there any changes to the agenda? Seeing none; we'll adopt those by consensus.

APPROVAL OF PROCEEDINGS

CHAIRMAN GILMORE: Second, we have approval of the proceedings from the May, 2016 meeting. Michelle.

DR. DUVAL: In reviewing the proceedings, I just noted that Mr. Chris Batsavage's name is noted throughout the meeting, and he actually was not here that day. I was here that day representing North Carolina; so perhaps there was another Chris around the table who might have been speaking that day.

CHAIRMAN GILMORE: I believe that was from the federal government, so we apologize for that. We would never mistake you for Chris Batsavage, Michelle. Thanks a lot; we'll make that change. Any other changes to the meeting minutes? Okay, we'll take those as adopted. Our next agenda item is for public comment.

PUBLIC COMMENT

CHAIRMAN GILMORE: Before every meeting we have a period for public comment on items not on the agenda. I know there are a bunch of people that would like to talk later on when we get into motions. But this is just a time for issues not on the agenda. Is there any public comment? Seeing none, we'll move on to our next item.

REVIEW OF RECOMMENDATIONS FROM THE ADAPTIVE RESOURCE MANAGEMENT SUBCOMMITTEE, AND REVISIONS TO THE ARM FRAMEWORK

CHAIRMAN GILMORE: Our first business item is going to be a review and consideration recommendation from the Adaptive Resource Management Subcommittee, and revisions to the ARM Framework. We're going to have a presentation from Jim Lyons.

MR. JAMES LYONS: Good afternoon everyone, my name is Jim Lyons; I am with USGS Patuxent Wildlife Research Center, and I am the Chairman of the Adaptive Resource Management Subcommittee, and I'm here to provide some recommendations from recent work reviewing the ARM Framework of the Subcommittee. I will start with a little bit of background about the ARM Framework and how we got here. The ARM Framework was established by Addendum 7, and as far as I know, is the first of its kind in a multispecies management approach; especially between a fishery and bird conservation.

But we have a multispecies approach to predict the optimal strategy for horseshoe crab harvest. The two main monitoring programs in this framework are the Virginia Tech Trawl Survey for

the horseshoe crab population monitoring, and a mark-resight approach to monitoring the stopover population of red knots.

The entire adaptive management framework, like all adaptive management frameworks, is a two-phase approach. We have an initial setup phase, where you identify the objectives of this decision, the options that are available to you, some models, some population models in this case of system dynamics and the monitoring that you need to make good decisions.

Once you have the setup phase complete, you can enter this iterative phase where you regularly make decisions; in this case an annual decision about the harvest decision. It is also customary in adaptive management frameworks to periodically revisit the setup phase and review those aspects of your decision framework that I just mentioned; the objectives, and your options and your models, and your monitoring, and see if you have those aspects specified correctly and if you require any changes.

That is what recent work has been about, is revisiting the setup phase and reviewing some of these aspects of the decision-making framework. In recent years the harvest recommendations have been 500,000 crabs; males only. I want to point out a couple of aspects of the mortality estimates in the horseshoe crab population dynamics model that will help us understand some of the options that I'm going to present.

In the population dynamics model, we have two sources of mortality. There is a natural mortality process, and then the harvest recommendation; the mortality associated with that harvest recommendation is subtracted from the crabs that have survived natural mortality. In this process of projecting the population, we have a natural mortality process; and then we subtract whatever the recommendation is.

It will be helpful to keep those two sources of mortality in mind. In the fall of 2015, the TCs and the ARM Subcommittee recommended revisiting the setup phase. In February of 2016, the ARM Subcommittee presented five potential review items to the board; some of them were considered short term review items that could be completed in six to eight months, some of them were longer term things that would require one to two years to complete. At the February meeting, the board tasked our subcommittee with completing the three short term review items.

Those are listed here at the bottom of this slide, and the things I am going to report on today. We're going to talk about the monitoring program and our evaluation of the current monitoring that is; is our monitoring effective and accurate, do we have the right data involved, are we using the best available data, and can we make some improvements to the monitoring program. We're also going to talk about the harvest packages and a review of those packages, and do we have them specified correctly. Are there new options we would like to consider or more options we would like to consider? Then finally, we have this objective function, which has several parts; and we evaluated different parts of the objective function to see if it was specifying our objectives correctly. I'm going to report on those three aspects of the ARM Framework. The first short term review item is evaluating the monitoring programs that we have.

The first aspect of that is an evaluation of the Virginia Tech Trawl Survey. The adaptive management framework was designed essentially around the Virginia Tech Trawl Survey. It is the most direct monitoring of the Delaware Bay horseshoe crab population and is the most appropriate monitoring of the horseshoe crab population for this decision making framework.

However, funding for the trawl survey, as you know, has been inconsistent and has lapsed in some years. But given our review of the benefits of the Virginia Tech Trawl Survey, our recommendation is to continue this Virginia Tech

Trawl Survey in future years; since it supports the adaptive resource management model and provides substantial and important data for this assessment.

Additionally, we also recommend or support the recommendations to estimate the proportion of the Delaware Bay population that is available in time and space in this monitoring, and also assess the selectivity of gear used in the survey. These are two aspects of the Virginia Tech Trawl Survey that these two assessments might be improvements to this monitoring program, and would be therefore improvements to the ARM Framework; and so we support that.

The second aspect of the monitoring review was to evaluate abundance indices from other surveys. You can see four surveys listed here that in the years when the Virginia Tech Trawl Survey wasn't available, we developed a composite index using all four of these surveys and correlating these surveys with the Virginia Tech Trawl Survey; essentially to predict what the Virginia Tech Trawl Survey would estimate if it had been run.

There was fairly good correspondence between this composite index, based on these other surveys, and the Virginia Tech Trawl Survey. In some ways, this was an effective work around when the Virginia Tech Trawl Survey was not available, and so our recommendation is that if the Virginia Tech Trawl Survey is not funded, a practical alternative is to continue to use this composite index of abundance based on data from these other surveys; although it is somewhat of an ad hoc approach and an indirect monitoring of the Delaware Bay population.

The third aspect of the monitoring review is to evaluate mark/recapture approaches to estimating the horseshoe crab population; and there have been two mark/recapture studies in evaluating or trying to develop ways to use mark/recapture to monitor horseshoe crabs in Delaware Bay. That is Smith et al in 2006 and Merritt on 2015.

Both of these studies were considered maybe partly successful, because of the large amount of tagging that seems to be required for mark/recapture approaches to be a viable way to monitor the horseshoe crab population around the Delaware Bay region. While there is some potential for these kinds of approaches, there is more work to be done here before this is ready for management decision making.

Our recommendation at this time is that mark/recapture is not a viable option for estimating the horseshoe crab abundance within the ARM Framework; therefore, it should not be incorporated into the model but should continue to be developed for future consideration. The fourth aspect of the monitoring review was to look at the red knot population monitoring program. This evaluation essentially consisted of developing or documenting the study design and a mark/resight sampling plan for this mark/resight estimation; that is essentially, how do we go around to all the beaches around the Delaware Bay and collect this mark/resighting data in an effective way. We did not develop any new protocols, but implemented.

We took this documentation of the study design and the sampling plan, and we met with the shorebird monitoring teams from Delaware and New Jersey; and renewed our efforts to collect the data in a way that is consistent with the model. The mark/resight estimates are always larger than estimates that come from the aerial surveys that are conducted, and there is some disagreement among the subcommittee members of the source of these discrepancies, and those things are described in the report that we provided.

Our recommendation is to continue the mark/resight data collection program with renewed effort to collect the data according to the sampling plan; and in a way that is consistent with the modeling that's done. Our final aspect of evaluating the monitoring program was to

evaluate, incorporation of biomedical data into the ARM Framework.

As you know, the biomedical data and biomedical mortality was not previously included in the ARM Framework, but current estimates suggest that biomedical mortality is 8 to 12 percent of coastwide mortality; and so it would be an improvement in the ARM Framework if we can include this known source of mortality in the decision making process.

Given the consideration of the biomedical data, and maintaining confidentiality, but using that data as part of the stock assessment, we also evaluated the potential to include biomedical data in the ARM Framework. We developed and evaluated five different options or five different ways that we could evaluate that use of biomedical data.

Our first general recommendation, and the subcommittee was in large and strong agreement about this, is that biomedical mortality should be accounted for in the ARM Framework. We did come to a consensus option; but I am going to present today a majority option and a minority option for your consideration.

This is a description of the majority option, which is; adjust the harvest packages to account for biomedical mortality of females. The harvest packages would be adjusted for mortality, but the subcommittee understands the importance of maintaining confidentiality and also the importance of not placing a cap on biomedical mortality.

What this option does with this change to the packages is create an allocation decision for the board between the biomedical mortality and the bait harvest. In this majority option, the packages would be changed every four to six years; and at that time we would calculate a running average, a three-to-five year average, a recent year average of the biomedical mortality and adjust the packages to reflect this biomedical mortality.

We created an example here in the table with the current harvest packages on the left hand side of this table; and you see the five packages there. Those are the packages that we have been using since the framework was adopted. On the right hand side of the table to the right of the dark heavy line, we see an example that was created using recent data; and it would show the total harvest under this example for the majority option. I've put them there close to each other so that you can see, and I would like to emphasize, the minimal amount of change that is occurring with the packages, given this option.

The biomedical mortality for females is included, and the packages change in a small way. To the right of the total harvest columns, for example, we see the biomedical data. These are example numbers that come from recent data. But this is an example of the amount of biomedical mortality and how those numbers are added to create the new packages.

Finally, on the right hand side of this table, we see the example bait harvest that would result. Under this option, if biomedical mortality increases over time, and horseshoe crab populations do not increase; then bait harvest does decline. But this is the preferred option, because first of all, it maintains confidentiality.

The way that the biomedical data are used would maintain confidentiality of that information. It does not place a cap on biomedical mortality. It minimizes the changes to the packages; the new packages would be fairly similar to the current packages. Then finally, it is the most transparent option; that is the harvest packages are an accessible, visible part of the ARM Framework, and it is very explicit and transparent here how the biomedical data would be incorporated.

The minority option is to account for biomedical harvest in the population dynamics equations only of the ARM Framework. Under this option we do not create any new packages or change any allocation. We continue with the same current

packages, but we incorporate the biomedical mortality into the population dynamics equation.

That is, we do similar calculations periodically to estimate the running average of the biomedical mortality. In our population projections in making these decisions, we subtract not only the current packages mortality, but also the biomedical after natural mortality. The total harvest under this option is actually greater than the majority option.

There is one issue that the subcommittee would like to point out is that the mortality associated with crabs is variable and not fixed; but we could potentially update this value every four to six years. The other thing that I should point out is that because of the way biomedical mortality would be added to the current harvest packages, the total overall harvest is actually greater under this option; and there is the potential that this option could lead to more conservative harvest recommendations in the future if populations don't increase.

That concludes the first short term monitoring review item. The second review item was to evaluate alternative harvest packages, and in recent years, Package 3 has been selected consistently at 500,000 male crabs and no female crabs. In considering the potential to add new packages or add more packages, or create new packages, we evaluated several alternatives.

But the subcommittee came to the conclusion that adding new packages is not likely to change any recommendations, because of the way there are utility thresholds for the horseshoe crab population and the red knot population. While we are below those abundance thresholds, the recommendations are unlikely to change no matter how many packages you have available. They are still unlikely to be picked. Our recommendation is that we do not recommend adding new harvest packages to the ARM Framework as part of this review item; although the packages should be altered to address biomedical harvest. Our third short term review item is to evaluate the objective function here; and there are four aspects of this. The first one, the suggestion was made that we should change the order of red knots and horseshoe crabs in this objective function.

You can see the objective function here in the box. This is how it is dated, where essentially the objective statement says to maximize the harvest of horseshoe crabs while being constrained by red knot populations; and that is how we achieve these two objectives. There was a suggestion that we should reverse these two things and have the objective be, maximize red knot recovery constrained by having a horseshoe crab harvest.

But this is clearly not a decision framework or an approach to decision making that ASMFC is the decision maker, and so this is really not an appropriate change for us. Our recommendation then is changing the order of red knots and horseshoe crabs, and the objective statement is not recommended.

The second part of the objective function was to evaluate this two times multiplier on the utility of female crab harvest that we have in the reward function. This was put into the ARM Framework to reflect the market value with females being twice as valuable as males. We considered whether this multiplier should be part of the objective function, and is it still accurate?

Our conclusion is that it is accurate, and so our recommendation is that because the multiplier of utility of female crab harvest and the reward function reflects market value, it is recommended that it is left in the model. The third part of the objective function involved a sex ratio constraint on the utility of male crabs. This is an aspect of the objective function that actually is redundant with part of our population dynamics model for horseshoe crabs.

We evaluated removing it, and it resulted in only minor changes to the output of the model. Given its redundancy, our recommendation is that we

remove the sex ratio constraint; because it is conceptually redundant with aspects of the horseshoe crab population dynamics model. Then finally, with revisiting the objective function, we evaluated the utility functions for female harvest and their shape.

Currently, we have a knife-edged-step function for utility, and we evaluated an alternative, which is a sloped utility function. We reviewed some simulation work by Smith et al, and found that the slope function did not demonstrate a significant difference than the current knife-edged function.

There was very little change in population trajectories, and no biological reasoning for changing the utility function here; so our recommendation is given the lack of change between the two approaches, and a lack of reasons to change the current approach, we recommend no change from the current knife-edged function. With that, I will turn it over to Kirby.

MR. KIRBY ROOTES-MURDY: Just for the board's clarity on the preferred option that the ARM Subcommittee put forward for including biomedical mortality into the ARM Framework, this would result in needing a new addendum to the FMP. What I have on this slide is just a breakdown of how that would proceed. If the board were to go forward with -- the best way to look at it would be two prongs -- the recommendations of the ARM Subcommittee and wanting to go with the preferred option. Then leaving this meeting, we would have to have an addendum initiated. At which point staff would go back, work on this likely with the ARM Subcommittee and the Technical Committee; pull together that document, bring it before the board, likely via conference call at some point either at the end of August or the beginning of September.

Then the board would need to approve that document to go out to public comment, so that there would be 30-day public comment period where there would be public hearings. The AP, the TC would be able to chime in again, and then the board would consider the document for final approval at the annual meeting in October.

That is just one way this would go forward if the board's preference is to include biomedical mortality with the preferred option the ARM Subcommittee put forward. The other thing to just note is that the ARM Subcommittee is able to make all these other recommended changes to the ARM model for the 2017 fishing year.

Our normal specification process is still -- we're keeping that timetable, so at the annual meeting the board would consider 2017 harvest specs; either with options that come out of that addendum, or kind of a status quo approach. Just to clarify that for the board at this point. Are there are any questions or comments specifically on the ARM Framework recommendations that the subcommittee has put forward? If not, we can move on to the Technical Committee's report and then the APs report; whatever is the pleasure of the board.

CHAIRMAN GILMORE: Mike Luisi.

MR. MICHAEL LUISI: I am interested in the harvest package statement that was made during the presentation regarding the consideration for harvest packages that include some female harvest in the bait industry. This board tasked the work of the ARM Subcommittee to evaluate that and put forth to the board options for potential consideration on small levels of female harvest to help revitalize some of what the bait industry has lost.

I'm interested in your comments regarding why, by taking that one step further and perhaps including that in an addendum; it sounded like to me that we would be wasting our time, and that we would still find ourselves in the position only to have one option to select from when we were talking about the packages that have been

selected over the last few years. I don't know if you can just elaborate a little bit on that.

MR. ROOTES-MURDY: Yes, just for the board's clarity. Again, I believe it was November when we first started talking about this. We heard from the board an interest in having female harvest options outside of what is already in the addendum. The ARM Subcommittee went back, looked at a number of possibilities. ARM Subcommittee members drew up a bunch of options, which are included in the report; they are in the appendix.

But the bottom line was that even if you wanted to add in these additional harvest packages, the thresholds that are set up in the ARM model currently, need to be exceeded; in terms of increasing the population above them, in order for any package to be selected that includes female harvest. That is why we're currently still at that 500 male crabs preferred pot package. Without any changes to the abundance estimate, then even adding a bunch more harvest packages wouldn't necessarily move the needle to select them.

CHAIRMAN GILMORE: Follow up, Mike?

MR. LUISI: Yes, please. Okay, I get it. Just another question, when would be the next time that we might get a peek at abundance; and then how were the thresholds ultimately established? Were they based on the assessment, or were they just selected as a number of horseshoe crabs that we ultimately want in the population?

MR. ROOTES-MURDY: I'll answer the process issue or question, and then I'll turn it over to Jim Lyons to talk about the threshold. The process would be, you know, this is this initial setup phase revisiting that we're doing right now. If the board were to move forward with the recommendations of the ARM Subcommittee, the next time would be four to six years from now; kind of the same timetable that was laid out in Addendum VII. Four to six years from now is when they would be revisited.

MR. LYONS: Yes, and with respect to how these thresholds were developed, these were created during the setup phase that I mentioned and were developed in stakeholder meetings. There were several meetings back in the early years to identify these utility thresholds and set these population thresholds. I believe the current figure is 80 percent of estimated carrying capacity, and there was some literature and some research on estimating carrying capacity; and the stakeholder meetings chose that threshold.

MR. ROY MILLER: It appears that any accommodation for biomedical mortality will result in a decrease in the present 500,000 male crab harvest scenario. Am I correct in that assumption? In other words, if biomedical mortality is incorporated into the ARM model that 500,000 number of male crabs is going to decrease; am I right?

MR. LYONS: Yes, let me try to address this question. Yes, the biomedical -- the allocation to bait harvest is reduced as biomedical is incorporated under the preferred option. The important thing to point out is that under the preferred option, we've changed the packages very minimally, and so if the populations stay the same the ARM Framework should continue to operate as it currently is right now.

With the minority option, we don't change the packages and the implicit allocation to bait harvest remains the same. But in changing the population dynamics model the way that we will, under the minority option, you actually have a greater total harvest; and so a greater subtraction after natural mortality.

That has the potential to lead to more conservative packages. We don't have any simulations or any evidence of that; but I say that simply out of first principals and a population dynamics model. If you're subtracting more

harvest mortality, it seems reasonable to think there is a potential to move to more conservative packages from say 500,000 males only to Package 2, or even Package 1.

MR. MILLER: If I may follow up, Mr. Chairman.

CHAIRMAN GILMORE: Go ahead, Roy.

MR. MILLER: Is there any compelling evidence that the present harvest rates are constraining the population recovery of horseshoe crabs? In other words, it seems to me if we're going to contemplate reducing say, the 500,000 male only horseshoe crab harvest, we would have to have compelling evidence that in fact that given level of harvest today is still constraining the recovery of this population. Is there evidence to that effect?

MR. ROOTES-MURDY: I'll take a stab at this and then maybe turn it over to either Jim or our Technical Committee staff to provide further comment. We are still operating without a stock assessment to give us a stock status for the Delaware Bay region, so when we're looking at the ARM Framework, we're not considering the stock assessment right now. Our data inputs are the Virginia Tech Trawl Survey and in the absence of that, we have the composite index.

We have information on harvest rates over the last few years, and last year, in particular on the regional level, the Delaware Bay region states had lower bait harvest than they had in previous years; but there are a couple of factors that may be contributing to that in terms of stockpiling some crabs, carrying over from one year to the next. There are a couple of factors that may be influencing the Delaware Bay population currently, but we don't have an overall indicator of how the population is doing.

MR. LYONS: I might just add that the population monitoring that we have for crabs suggests maybe a stable or slightly increasing population, and so it may be that over time the population will continue to grow and then it is likely that the ARM Framework recommendation would change. But our evidence right now is that the smartest thing to do, given the objectives that we have and the monitoring information that we have, has been the 500,000 crabs.

MR. BRANDON MUFFLEY: I have a couple questions. One, a hopefully easy question. Jim, you had presented in the index the composite index that you all have created, the indices that you used in that index. You talk about the New Jersey/Delaware Bay Trawl Survey, and up on the slide you had indicated the Surf Clam Dredge Survey that we use.

But in the memo it says our New Jersey Ocean Trawl Survey is used in that index. I was just looking to see what indices are actually used; mostly because funding for one of them is more subject than the other one, so if we're relying on the Surf Clam Survey, which is more variable in terms of funding, versus our Ocean Trawl. I just wanted to clarify which surveys are actually used for the composite index first.

MR. LYONS: Yes, I believe it is the Ocean Trawl and not the Dredge, so there was a misprint there somewhere.

MR. MUFFLEY: Okay, thank you, and then on these sort of harvest packages. Can you give me a little bit more information in terms of -- you said that if we allocate under these harvest packages, some harvest to the biomedical industry, we're not putting a limit on that biomedical industry; although we're assigning a specific quota it seems like to them.

I'm trying to understand how we're not impacting the biomedical industry harvest by actually having a quota assigned to them; and how are we giving under Option 3, some mortality assigned to females when the option is for a 500,000 male-only harvest, so two questions on that?

MR. LYONS: The reason I say it is not a cap is that the new harvest packages are created from the biomedical data. What we're doing is simply accounting for the known mortality that we have from the biomedical industry. Periodically, we create this running average, and then we add that mortality to the current packages.

I say it is not a cap, because this is a limit; this is only what you can take; it is acknowledging what has been taken and the harvest that has been going on. With the current set of packages, I should add that for it to be considered a cap, the biomedical mortality would have to increase by an order of magnitude.

With a small amount of time we can come up with the numbers of crabs that would have to be bled, before we would exceed the total package; and all of it going to biomedical. But it is an order of magnitude increase in the biomedical that would be required before this would actually be any kind of cap or limit. I've forgotten the second part of your question. I'm sorry, can you repeat that?

MR. MUFFLEY: It was just how are we allowing for mortality to females under the one scenario, which was a 500,000 male-only harvest and you're allocating some of that mortality to females?

MR. LYONS: Right, okay, thank you. One thing that we should point out with this preferred option is that it does create this allocation decision for the board; and those packages list a certain amount of female harvest, but the board would designate that that is female harvest for the biomedical industry only; and if we were to look at the table, you would see that the allocation debate would be zero females. The female harvest in the new packages is for biomedical only.

MR. ROB O'REILLY: I've been concentrating as I went through the materials on how challenging it is going to be and has been for an index of abundance. I guess I'm wondering two things; one, for the composite index when the trawl survey was not available, and using other surveys and going through a correlation and regression and a number of sort of permutations there. What kind of rigorous review has that methodology received? That is one question.

The second question is tied in. It indicates that the efficiency of the trawl survey was looked at in 2011, and certainly was not 100 percent; and so the composite index also suffers from underestimation of abundance. I'm just wondering, has that been addressed in any way, or is that something that is still just as left unknown?

MR. LYONS: I will take a stab at this. The composite index in that work was done by our subcommittee in response to the lack of funding for the trawl survey. I think we did go with the status quo for one year, but then we tried to develop an alternative approach based on other surveys.

We produced this approach, and I believe presented it to the board. But that as far as I know, has not undergone a peer review process beyond the subcommittee. With respect to the efficiency of the trawl survey, the subcommittee recognizes it is not 100 percent and that if we understood the catchability of that survey better, that would be an improvement to the monitoring program.

CHAIRMAN GILMORE: All right Rob, make it quick, because we've got two more presentations to go through, and we are going to run out of time.

MR. O'REILLY: Quick as lightning, Mr. Chairman. The question is; is that something that will be looked at this year, the catchability? Will that be further addressed?

MR. ROOTES-MURDY: Yes, we asked Eric Hellerman to consider this that gear selectivity in

doing the survey this fall. These recommendations were made known to Eric Hellerman and he is receptive to conducting this study in the fall.

CHAIRMAN GILMORE: Okay, I have Stew Michels and then I've got Mike Millard; and then we're going to move on.

STEWART MICHELS: Thanks very much, Jim. This is a lot of work by the committee, and it is certainly appreciated by this board. Can you help me understand this biomedical mortality component a little bit better? I don't quite understand how it shouldn't be additive; instead of incorporating it into the overall mortality and essentially spitting out a quasi-quota for the biomedical fishery.

Was there any consideration that we just consider this biomedical aspect as additive incorporated into the model? I guess kind of the secondary option? Then just treat it as an additive component to mortality and as not a portion in any further manner?

MR. LYONS: Yes, I'll take a stab at it, Stew and Kristen can perhaps help. Yes, I think what you are describing is close to the minority option. It is the additive in that sense. I mean, it is a little more clear that it is additive there under the minority option. But there is a feedback from the harvest recommendation to the population dynamics model in all cases.

Even with the majority opinion, the new packages and the total mortality associated with them is additive to natural mortality. Because there is feedback in all cases between what we recommend for harvest, and the population dynamics; the two approaches are similar in that way. It is the amount of change in the packages and the actual total harvest where the results are different.

CHAIRMAN GILMORE: Okay, Stew, go.

MR. MICHELS: But you also contend that the change is so slight, right; that the biomedical portion is so slight that it would take basically a doubling of the amount of biomedical harvest to really make a difference. Is that what I understood that you said earlier?

MR. LYONS: With respect to the cap part?

MR. MICHELS: Yes.

MR. LYONS: No. It is much more than doubling. The biomedical mortality would have to increase by an order of magnitude ten times what it is now, before the whole harvest package would be allocated to biomedical.

DR. MIKE MILLARD: I'll try and be quick. I did want to circle back to Roy's question about the inevitability of a reduction to the bait harvesters under either of these options. I'm going to ask, I guess, Jim. Tell me if I have this right. Under the preferred option the model remains ignorant of the biomed harvest; and that adjustment is made after the model gives us its answer.

That is clearly a reduction to the bait harvesters. Under the minority option then the biomed mortality is added into the front of the model. The model now sees more mortality, and goes through its optimization routine; and as you said, that compounds and ends up in a larger mortality seen at the end of the run and gives us the chance of it picking a more conservative harvest package.

Now I know, and Dr. Smith's simulations weren't exactly designed to get at this question, but he did run simulations with this model package to see how it behaves; how it performs. In his simulations the model optimization scheme never landed on Option 2, it always went from 3 to 1, which is total moratorium. I guess I'm asking you, if we were to do the minority option, you cannot discount that we would land on Package Number 1. That is a possibility if we go down that road, it seems to me; total moratorium.

MR. LYONS: I would agree with your assessment, Mike. I think everything you've said there is correct. Because of the way the minority option is implemented, and the tendency of the optimization routine, when it is seeking a more conservative recommendation, tends to skip over Package 2 and select Package 1 at times when reducing harvest is the optimal solution.

Yes, I think it is accurate to say, without knowing the answer right now ,that just on first principals of this modeling approach, when you have a greater total mortality there is a greater change that you would end up with a more conservative package; and in this case, perhaps a moratorium.

DR. MILLARD: A quick follow up if I may, Mr. Chair.

CHAIRMAN GILMORE: Go ahead.

DR. MILLARD: If it doesn't change, if it still lands on Package Number 3, then we are left right where we are now. We have the same harvest package, the bait people get it all, and with a known up to 10 percent removal by the biomedical people that again is essentially ignored, or not accounted for by us; it seems to me under that minority option.

TECHNICAL COMMITTEE REPORT

CHAIRMAN GILMORE: Okay, we're going to go on to Steve Doctor, who is going to give us a report from the Technical Committee.

MR. STEVE DOCTOR: Hi, I'm Steve Doctor from Maryland Fisheries Service; and today I'll be acting in the capacity of the Chairman of the Horseshoe Crab Technical Committee, and also representing the Delaware Bay Ecosystem Technical Committee. The Technical Committee was given this information just as you have, and we've come up with some recommendations. We met by conference call on July 28. The ASMFC staff presented the ARM Subcommittee review and recommendations. We evaluated the subcommittee recommendations and considered the biomedical mortality estimate inclusion, and discussed biomedical mortality threshold exceedance; which is another word for the standards for the biomedical companies.

The Technical Committee was in agreement that the ARM Subcommittee review is acceptable. Some of the comments that came from the committee were further exploration of alternative harvest packages with the female harvest. There was kind of disappointment that that wasn't pursued further.

They also had a recommendation that further work be done to reconcile the red knot mark/recapture abundance estimate with the aerial estimate. There seems to be some things that need to be worked out between those two. As far as including the biomedical mortality in the ARM Framework, the Technical Committees agreed that the ARM Framework, to be properly run, should incorporate biomedical mortality.

The majority of both technical committees were in favor of the ARM Subcommittees preferred option; the reason cited that by using an average, it does not violate confidentiality rules, it is transparent and explicit of mortality estimates, and it treats harvest types similarly as removals. There was also minority support for the ARM Subcommittee secondary opinion.

The reason cited that it accounts for biomedical mortality without changing harvest packages, would not require an addendum, and is a transparent inclusion in the ARM Framework. Biomedical mortality in the ARM Framework continued. If the addendum is developed, sensitivity analysis should be done to see how both options would be implemented.

That means like we're discussing that if you did the method where the mortality was taken out of the model, it would be nice to do some sensitivity analysis to see actually if it would choose 1, 2, 3 or 4, whether that would actually change; because the mortality has already been

experienced and we would like to see if it changes the reaction of the model.

Also, try the preferred alternative too, to see if it would change the outputs. Also, those in the Option 4 that is presented, the preferred alternative, they have recommendations on the amount of female and male removals. Because this process is going to happen every four years and there is growth in the biomedical industry, it was a recommendation that there be a buffer; maybe 10, 20 percent on the amount that is given to the biomedical industry for growth, so that we wouldn't maybe hit a trigger that overruns the biomedical allocation.

Then there was also some confusion over jurisdiction and ability of the board to limit biomedical harvest. Both technical committees requested that the board determine jurisdiction for possibility of limiting biomedical collection and harvest. Then the biomedical threshold exceedance recommendations were basically our recommendations for the biomedical industry.

Some of the Technical Committee members requested requiring biomedical companies to contribute to funding to the Virginia Tech Trawl Survey and other studies of biomedical mortality. There was not a lot of public support for the ARM Model; and I think that is all I've got. Are there any questions?

ADVISORY PANEL REPORT

CHAIRMAN GILMORE: Questions for Steve. Well good, we'll move right along then. We're going to go to the Advisory Panel report. Just give us a second here to get set up. Okay, Jim Cooper is going to give us a report from the advisory panel.

DR. JAMES COOPER: Yes, the advisory panel received the discussions of the ARM proposals, as you've just heard; and I won't elaborate on that. Going directly to the Advisory Panel report, let's go to the comments with a panel that begin on the bottom of Page 1; where we point out that the AP members were not in favor of the ARM proposal to include any biomedical mortality.

We felt that this was inadequately supported at this time and perhaps premature; we were only given ten days to even study this matter. Some of the problems that they did have that started with the fact that the preferred option would potentially bring the bait and biomedical harvest industries in conflict with one another, and actually we don't think that is in the best interest of everyone.

Obviously, we're very different industries, but we would rather try to accommodate each other whenever possible. The mortality estimates from bleeding, we think, are insignificant with respect to bait fishery harvest; in fact, we think really insignificant with respect to the number of horseshoe crabs that are in the ocean, so that including the ARM models would actually, we think, go against the intention of the ARM Framework as previously identified.

There was concern that neither of the options has been tested through simulations and perhaps premature for the board to consider at this time. Also we're concerned that the biomedical data being introduced at this point would be the first step in creating limits to collecting horseshoe crabs for the biomedical production of LAL reagent.

We think that limiting LAL would have significant impacts, certainly on the biomedical community; and I will point out a little bit later that that the FDA of course has no impact in this area, other than to require biomed companies to return them to the sea. They have nothing to do with collection.

However, they will be very interested should there be any threat to the availability of reagent for the industry. We feel like we weren't given much time, and also the fact that these committees, once they got around to biomedical discussions, would have benefitted from the presence of a biomedical expert to help them

deal with some issues; misinformation and things like that.

We certainly felt that we had not been consulted by subcommittee in the development of these options. The AP did indeed take exception to most of the ARM recommendations. We feel that this could be revisited over the next two years. I'll take questions at this point. I don't want to belabor this issue; time is running short.

CHAIRMAN GILMORE: Do we have any questions for Jim Cooper? Okay, seeing none; I think what we're going to try to do is maybe break this into two pieces. We essentially need a motion to adopt some of these recommendations. The biomedical package seems to be the one that is going to get a lot more discussion.

With the pleasure of the board, if somebody put up a motion, actually, for the other points or whatever, it would be helpful to move this along. Well, the other option is we put this all in one package one way or the other, and we could get bogged down. Brandon.

MR. MUFFLEY: Following that vein, delay this putting this all together; I agree let's try to separate it out. **Move to approve all ARM Subcommittee and Technical Committee recommendations except for the biomedical harvest Subcommittee packages.**

CHAIRMAN GILMORE: I have a second from Robert Boyles. Do we have discussion on the motion? Seeing none; is there any public comment on the motion? Seeing none from the public; Mike Luisi.

MR. LUISI: I was prepared to take a little bit of a different approach and also include in this addendum some analysis on the alternative harvest packages, which include female harvest; as part of the bait industry. Going back to what Brandon said earlier about the harvest package as it is selected now with 500 male crabs, and then the allowance of female harvest at the biomedical facilities.

I just think it is a difficult explanation to make as to why a small level of 25,000 or 30,000 crab harvest can't happen. I don't understand why it can't. I can't explain it to my public, who have asked me to support them, and asked our commission to support them on their interests. I absolutely agree that this biomedical industry issue on mortality needs to go out to the public; and we need to get feedback. **But I would like to incorporate another piece to this, so if I may, Mr. Chairman I have a motion to substitute.**

CHAIRMAN GILMORE: Go ahead, Mike.

MR. LUISI: **Move to initiate an addendum to the horseshoe crab fishery management plan; to address the Adaptive Resources Management Subcommittee's recommendations to the ARM Framework regarding one, mortality associated with the biomedical industry and two, bait harvest packages which allow female horseshoe crab harvest as presented in Appendix C of the framework review.**

CHAIRMAN GILMORE: While we're getting it up there, do we have a second to this motion; or do you want to see it first? Craig, are you seconding the motion? Okay. While we're getting it up, do we have questions, comments, or discussion on the motion? Mike, do you want to take first comment crack at this?

MR. LUISI: Sure I'll say it again, and I've said it before. These are the two big issues that came out of the subcommittees recommendations. I absolutely appreciate all the hard work and effort that goes into those recommendations. The work that has happened since last year, I've been getting feedback from staff.

It is a tremendous amount of work, and I do appreciate it. However, I think there needs to be more public involvement in the understanding and the decision making that happens as a result of these two issues. I feel that the addendum process through the commission is just that process, and that by us selecting here today one

of the recommendations; we heard a minority and a majority opinion on the biomedical industry. We also heard that with the female harvest packages in the bait industry that it is very likely that the model will select the current package. But I would like to see what happened as a result of running the model through those different options, and then be able to make the decision at the end of the day as to the path we take. I think it brings the two big issues that we've been talking about for years to the table; and it brings it to the board so that we could ultimately make those policy decisions, and that is the purpose for me moving forward in this direction.

CHAIRMAN GILMORE: Other questions or comments?

MR. ROBERT BOYLES: Clearly, South Carolina has got strong interest in horseshoe crabs, and even horseshoe crabs in the Delaware Bay region. I just wanted to point out that we had an opportunity to brief our board a couple weeks ago about this fishery, the unique fishery that we've got in South Carolina.

Thanks to some good work by a number of our forbearers, I think we've got a really good program in South Carolina. I recall that some time ago there were conversations about, well maybe some options would include, let's turn every crab that is bled into bait. I think I made some strong comments against that at the time, because that is not consistent with the way we manage this fishery in South Carolina.

I was talking to my colleague from New Jersey about their fishery, and I would just, for my edification, for the board to know that we do get good data from industry on reported mortality. We think it is a well-managed fishery, we think it is very, very important. We place a high value on that biomedical fishery; to the extent that we don't allow horseshoe crabs to be used for bait. I just wanted to make those comments for the benefit of the board as we move into this discussion and try to sort out how we best manage this fishery.

MR. DAN McKIERNAN: Yes, I would be more comfortable with this motion if I had a Law Enforcement representative telling me that opening the female harvest was something they could control effectively.

CHAIRMAN GILMORE: Other comments. Do we have any comments from the public on this? No, okay seeing none; oh, Brandon.

MR. MUFFLEY: I'm still struggling with it from the biomedical industry; not even to my friend over in Maryland's perspective. I'm interested in evaluating what their options may be for female horseshoe crab harvest. I'm still struggling whether or not we really need; I think we need to account for the biomedical industry mortality, so that we have a complete picture of what is going on.

I don't think it is that significant, but I think we need to account for it; and I think we can do that with the alternative option that was presented that would not require us to go out to an addendum to evaluate that. When we talk about increasing in mortality, you know, when you're showing an increasing mortality, we may result in more restrictive measures.

That may be, but now you're accounting for new mortality; which isn't necessarily new, but it's new in terms of accounting for it through the modeling process. What may also happen is if we're showing increasing trends and to some regards in the Delaware Bay population, this mortality is already taking place.

What may happen by accounting for it, you just may scale up the amount of horseshoe crabs that are available in the population. It may not be a negative response to the bait industry by accounting for this mortality. We don't know what the response is going to be just yet, but again, I'm still apprehensive to go down that road

of assigning quotas to the biomedical industry and reducing it on the bait side of things, where I think we can account for the mortality under the alternative package; which would not require an addendum.

CHAIRMAN GILMORE: Go ahead, Mike.

MR. LUISI: I'm just, Brandon I didn't intend in this motion to change from what I read your motion to be. I believe that what we would end up with here are alternatives in the addendum that would expand upon the work that has been done by the subcommittee and give the public that information.

If what I heard from Mike earlier indicated that by selecting the minority opinion, we could potential find ourselves at a moratorium. I think that information needs to be well vetted. I would expect that by going forward with the amended motion that we would be looking at both opinions as well as the additional bait packages as a further expansion from what we've already heard from the subcommittee.

MR. O'REILLY: I also think that the mortality from the biomedical can be accounted for in the alternative approach, and I heard Steve Doctor representing both technical committees, indicating that a sensitivity analysis or something along those lines could be done to see what happens with these two alternatives; and I don't think anyone wants to just come to another meeting and find out, well the conservative nature of the model ended up on Package 1.

I think that needs to be short circuited, and we need to know about that; but all in all, I expect based on the comments earlier that this is a small amount of mortality relative to the whole stock, so I, too, think the second alternative is probably the way to look at this, get it in the model itself, and go from there.

CHAIRMAN GILMORE: Any other comments? Emerson.

MR. EMERSON C. HASBROUCK: In reviewing the main motion and the substitute motion, I'm not clear really what we would be approving in the main motion. It says to approve all adaptive resource management and subcommittee and technical committee recommendations except for biomedical. What are all the other recommendations?

CHAIRMAN GILMORE: Well, they were the ones that were gone over in the first place, but there were five of them or whatever, so essentially what we're going to do is trying to approve the four and handle the biomedical issue separately. I think Mike has now combined them back together, and that might be a better solution to it.

Those earlier pieces, I think, would be part of this process. Are there any other questions before we caucus? Do we need a minute to caucus? All right, take a minute and we'll call the question. All right, the meter is running and Toni is giving me the high sign. All those in favor of the motion, well, first off, remember this is a motion to amend; so first we have to vote this one up and then we'll put it up as the main motion. **All those in favor of the motion to amend, please raise your hand, all those opposed; null votes, abstentions; motion passes 10 to 5 to 0 to 0. This becomes the main motion now.** Are there any comments on this from the board before we vote?

PUBLIC COMMENT

CHAIRMAN GILMORE: Okay, anything from the public? Okay we'll take some brief public comments on this. Benji, do you want to go to the public microphone?

Benji, I'm going to let Jim Cooper go first. Jim is the AP Chair, but he actually wants to make some comments, not as the AP Chair, which he would normally go back to the public microphone but because it is so far away, we're going to let him do it from here. This is individual comments from Jim.

DR. COOPER: I think you have a document that has my comments, and it is misleading in the sense that I signed it off as Chair of the AP, but these comments are not representative of AP comment; although many would agree with me. I am going to try to cut this as much as I can. I think the ARM proposal starts out by reminding everyone that about 2011 or 2010 the so called mortality threshold was exceeded and the board was supposed to do something. It suggests that nothing was done; and that actually is not true.

In 2011, the board asked that the commission enable a study of best management practices to try to harmonize the way that crabs are protected in the biomedical facilities; and recognizing that the FDAs good manufacturing practices really dominate what goes on in our industry. We thought well, we'll set up procedures that mimic that and help us with our training of waterman, training of handlers, and of course writing appropriate procedures to protect the crabs would be a good way to do that.

This was accepted by the board and not any other action was taken. Danielle Brzezinski was running things at that time, and actually I don't know that the board actually voted on anything at that time; in fact I don't think they did. But nevertheless, in discussing some of the ARM issues, we think they may have been influenced by misleading information while preparing the documents that we've discussed.

For example, it has been discussed that there is concern that the collapsing TAL industry in China will eventually pressure U.S. LAL market if we have to supply them with reagent. Actually, I've looked at the marketing analyses, and it shows that Chinese firms do less than 20 percent of the worlds endotoxins tests; therefore, we could absorb that should it be necessary.

In considering the growth of endotoxin testing, there is an only modest increase anticipated over the next few years. Now what happened in the first decade, the previous decade was that there was a big increase that occurred, because FDA suddenly required the drug industry to greatly expand testing of in-process samples and starting materials to make sure that they never got to the final product with any potential contamination, so you see this was FDAs regulatory expectation that caused a jump in LAL consumption at that time.

But it has pretty much leveled off now, and indeed, the FDA would react to anything that looked like a curtailment of the reagent. There is also the notion that LAL can be immediately replaced by a recombinant product. That is not true. The R factor C only contains one of the enzymes as part of this system; LAL reagent has a three enzyme reagent. It is certainly more robust, but the big issue is that using the recombinant will require expensive fluorescent readers, rather than the standard inexpensive right readers. That is a cost issue that would profoundly limit this matter. I am sure there are other issues that might have come up like this. I think the presence of a biomedical expert at the time of these discussions could have avoided some of these things. Now our interest in the biomedical research regarding post release mortality, we've been discussing this to some extent, even today.

Now mortality estimates in the biomed industry is really difficult to study, because horseshoe crabs aren't laboratory animals, they are arthropods. It is really almost impossible to adequately reproduce post release environments for these kinds of studies, and that is the reason we see publications suggesting that the post release mortality may be very high; 30 or 40 percent.

It is the inability to study these in a laboratory situation that brings about these kinds of overestimates. I would like to remind you that horseshoe crabs are hardy; they've survived for millions of years and they are resilient. I was associated with Cavanaugh Laboratories about 40 years ago, and they maintained a big tank of horseshoe crabs in order to study their coagulation systems.

One night salt water leaked from the tank. They filled it up with tap water, just fresh water; and the next morning the staff found 50 or so horseshoe crabs floating lifelessly on top of the water. They picked them up and carted them off to disposal area very reluctantly, all despondently. Then the following Monday morning they get a call that says, would you come down here and pick up these crabs, they're crawling all over the place.

This is just a story that helps you understand that the crabs are resilient enough to even recover from a fresh water shock that made all of them look dead. This exemplifies the uncertainty of trying to reproduce a return-to-sea environment. Elegant research continues in South Carolina. DNR scientists there have been doing some elegant studies on the genetic diversity of the crabs in that state.

Their study concluded that genetic diversity was high. There was little to no evidence of inbreeding, evidence of a huge population offshore, she couldn't tell how big it was, but it is very, very large; certainly a positive indicator for adaptive potential, and this is Walsh and so forth. The fellers from South Carolina can tell you how to access that document.

By the way, a marketing specialist told me that there are approximately 60 million endotoxins tests done annually, and if we assume a loss of 60,000 crabs; that means that we're getting about a thousand tests for each crab that might be lost, and I think this is a tremendous bargain. Loss of a small proportion through the biomedical industry really is inconsequential and justified by immense value of the reagent.

If the board members believe that local marine resources are properly managing biomedical firms, and that the BMP document minimizes harm to the crabs, and that there is no value added to creating a third level of bureaucracy, certainly one that leads to limiting the horseshoe crabs in the biomedical area.

We think that the expenditures could be used more widely. Rather than pay for an addendum; we could probably pay for a Virginia Tech Trawl. I strongly urge the board to categorically reject the proposal ARM document with respect to the biomedical community. I think we could take a two year moratorium on this issue and allow us to update the BMP document, continue review and research to better understand post release mortality; and hopefully have a better working relationship with any technical committee or whatever that would be considering biomedical issues. Thank you very much.

CHAIRMAN GILMORE: Thanks Jim, we've got Benji and Dr. Schuster. Benji, do you want Dr. Schuster to go first? Is that okay? Okay, go ahead, doctor. Please keep your comments to about three minutes. We're really running short on time.

DR. CARL SHUSTER: I received a telephone call last night alerting me to the fact that I might be interested in attending this session; primarily because there was some concern about lumping together bait and LAL resources or mortalities. True that the bait is 100 percent mortality, and LAL, as Dr. Cooper has explained, is not as well understood.

For this reason I would not lump the two together, but actually if you wanted to learn something more scientifically, I would learn more about the reproductive system of the female horseshoe crab. As far as I know, there is no one today who knows much about the functional anatomy of the crab, the physiological aspects.

If you were going to form a baseline against which to compare what you're observing in experiments today on the impact of bleeding on horseshoe crabs, you would certainly want to know something about the physiology of the normal. The natural horseshoe crab female; is lacking. If I were going to do this thing, I would think in terms basically about the biology of reproduction in the females.

The second point I have, which is outlined here is that hearing that bait and LA were going to be lumped together, I thought, well, I can think of many other ways that you could lump things together; and certainly if you do that, you can come up with a list as I have, and there are many more things that should be added that indicate the scope of the mortalities that we're dealing with in understanding the horseshoe crab.

I went through and listed them, and then I drew a line and ascribed certain numbers to them. If I am anywhere near the ballpark, the loss of horseshoe crabs from both LAL and bait would be less than probably 2 percent of the total population. If you expanded that to 10 percent, you would lose 2.68 million crabs, and that doesn't seem like an overly heavy impact upon the population since that occurs sometimes in some of the natural phenomena; where crabs are destroyed.

That, I think, summarizes in effect the scope of what I just thought about in that short period from last night to now. My recommendation that you have someone who sincerely looks at the ecosystem approach to horseshoe crabs, and think in terms of the impact on crabs on, for instance, the surf clam industry, things of this nature; that you're not dealing just with horseshoe crabs, you're dealing with ecosystems, and there doesn't seem to be much concern about that, which I feel is probably the key to much of what you should be learning. Thank you.

CHAIRMAN GILMORE: Thank you, Dr. Shuster. Benji.

MS. BENJI SWANN: Okay, I'll try to be quick. I don't know if I can do that. My comments are --

CHAIRMAN GILMORE: Benji, could you just identify yourself.

MS. BENJI SWANN: Benji Swann, Lysate manufacturer in the state of New Jersey, and I have been since actually 1985. Adhering to the Atlantic States Marine Fishery Commission Interstate Horseshoe Crab Management Plan, the collection of horseshoe crabs for Limulus Amoeboctye Lysate is monitored by state agencies in the Atlantic States Marine Fishery Commission, but not part of the ARM Harvest Package.

This is due to one fact. LAL is a life-saving, critical, essential vital product for human health without any present alternative. Some suggest that a synthetic product can replace LAL. However, the synthetic product is not there yet, and perhaps never will be completely or at all. We cannot drive the market by constraining the biomedical companies. The market will drive itself.

A perfect example is the new LAL application developed by a biomedical company that uses 120th of the raw lysate. Point two, biomedical collection is separate from bait harvest and should be, as its activities are essential to human health and pose no threat to the horseshoe crab population. On average, eight to nine horseshoe crabs out of ten survive the process and can be found spawning years after bleeding.

The Delaware Bay horseshoe crab population has remained stable, slightly increasing for years, and estimated to be 20 million horseshoe crabs. If the entire mortality of 60,000 crabs associated with biomedical use is attributed to the Delaware Bay region, the impact is 0.3 percent. A quote from the ARM Subcommittee report July 16, 2016, refers to biomedical companies killing the horseshoe crabs.

Any small mortality is unintentional, and may be out of our control. I find it offensive that any member would accuse us of intentionally killing horseshoe crabs. Number three, when considering the adoption of the ARM modeling and the harvest package in 2010, the biomedical numbers were not included, and no substantial change in the biomedical numbers have occurred to warrant inclusion.

The biomedical numbers reported in 2014 are similar to the numbers from the year 2010; prior to the ARM adoption. As an aside, when I prepared a table for illustration, the 2014 numbers regarding biomedical collection were reported incorrectly. More biomedical crabs were bled than collected; this isn't possible.

This emphasizes a point; that numbers are good to refer to, but sometimes logic has to prevail. Point four, a reason given for the inclusion in the ARM was to make biomedical mortality more explicit. Right now the biomedical numbers are explicit, and listed in their own table. When I view the proposed ARM table with biomedical mortality included, the table begs more questions than it answers.

It is also misleading, giving one the impression that biomedical collection is limited. This is not the case, nor should it ever be. Another quote I read was, two stakeholders exploiting the resource; and again I find this offensive. We are managing the horseshoe crab population to be sustainable, and to prevent exploitation. Number five, comments on the proposed addition, first and foremost the introduction contains mortality from the biomedical harvest to date hit a high of 90,440 crabs in 2012, an increase of nearly 100 percent since reporting begin in 2004. Similar to the 2014 numbers, the 2012 numbers were erroneous as well. More crabs were bled than were collected. Okay quickly reviewing the biomedical tables.

The number of horseshoe crabs brought to the biomedical companies, Row A, jumped between the years 2006 to 2007. One reason could be more males began to be used for bleeding, and more males are needed to be equivalent to a female. Furthermore, this use of males may have been perpetuated by the adoption of Addendum IV in 2006.

I didn't have time to review this. Since then biomedical numbers remained in the low 500,000s, with the exception of the years 2011 and 2012; increasing to the low 600,000s. Specifically, when I looked at the recommendations and conclusions for the proposed addition, Number 1, I disagree with for the above reasons. Biomedical numbers should not be incorporated into the ARM model.

Number 2, since 2005, 11 years ago, confidential data is submitted detailing mortality at each stage. This information can be located within the biomedical table, Line D, reported mortality of biomedical only crabs from harvest to release. Numbers 3 and 5, years go by too fast. A three-to- five year review of BMPs would be sufficient.

Number 4, many of the companies have funded and are currently funding research to enrich the knowledge and understanding of the horseshoe crabs in the LAL product. To continually study the mortality of bled horseshoe crabs to get that perfect number that everyone will agree on, will never happen.

Each study has its own imperfections, but one consistent thread is found. The horseshoe crab's survival can be assured at a high level if the horseshoe crabs are handled with care and concern. Number 6, my last point, timing is fishy. The ARM Subcommittee's task was to review the ARM model, which is specific to bait harvest, review its assumptions and utilities and its usefulness in managing and advancing the horseshoe crab population.

Instead, it focused on biomedical activities and shorebird studies. The ARM Subcommittee document was 47 percent shorebird activities and shorebird studies, 15.5 pages of 33, 32 percent of biomedical related, which was 10.5 pages of the 33 pages; 6 percent was two pages of references and introduction, and 15 percent was a review of the ARM model and tagging, which was 5 pages.

Combined with its arrival in the ninth hour, something is very fishy. I urge you to vote not to include or list the biomedical numbers in the ARM package, and continue your good work in

managing the horseshoe crab populations. I'll take any questions if anybody has any.

CHAIRMAN GILMORE: Thank you, Benji. We're going to come back to Kirby, and we're going to go a little bit over the schedule first; so before we call the question.

MR. ROOTES-MURDY: I just wanted to outline to the board, I outlined earlier a timetable moving forward with an addendum that was based on the ARM Subcommittees recommendations. Under this motion, I just wanted to make sure folks were aware that this addendum initiated at this meeting would then likely be taken up to go out for public comment at the annual meeting; and then final action would be taken on it at the February 2017 meeting. In terms of the 2017 specification process, this addendum from what staff understands, would be separate to the 2017 specification process.

Then the last point is that this motion outlines specifically that the second item, there are two parts to this addendum, lists options that are included from the ARM Subcommittee's review. I just want to make clear that the first part is that also biomedical mortality; in terms of the decision point there. Would that be drawing from the ARM Subcommittee's review items, or additional work? Those are just some points to consider and clarify for staff.

MR. LUISI: On your last point, Kirby. It was my intention when making the motion that the first issue on biomedical mortality, there would be a range of alternatives to include the status quo; and then the two minority and majority opinions from the ARM presentation.

MS. KERNS: I just wanted to clarify. I think best case scenario is we can get you a document for review to go out for public comment at the meeting in October. But there is also a chance that it might not be available until February. It depends on how much work it will entail for the TC, because don't forget they still have to pull together the ARM packages for the board approval in October.

CHAIRMAN GILMORE: Good point, thanks Toni. All right, back to the board. Bill Adler.

MR. ADLER: Can I make a motion to postpone until the next meeting, this whole motion.

CHAIRMAN GILMORE: You can, but you need a second.

MR. ADLER: Guess not.

CHAIRMAN GILMORE: Motion fails for lack of a second, so back to the board. Are there any comments on the motion? Okay, do you need any time to caucus? Okay, I give one minute to caucus. Everybody ready for the question? **All those in favor of the motion, please raise your hand; all those opposed, null votes, abstentions; motion passes 13, 2, 0 and 0.**

DISCUSSION OF ADDITIONAL BAIT TRIALS

CHAIRMAN GILMORE: Thanks, everyone. We have one more order of business, which is on the bait trials, and I think we're going to turn this over to Bob Ballou; who is going to just make this so efficient and intro it, and get a motion and just get this thing going. Bob.

MR. BOB BALLOU: Yes, I am prepared to collapse a 30 minute agenda item into what might be just a two or three minute item; of course, that depends on the board's response. But I'll just say in brief, we've had some good discussion at our last few board meetings regarding alternative bait; which to clarify involves a composite or some other variation that uses less horseshoe crab relative to current levels, while continuing to meet the needs of whelk and eel fishermen.

With a view to maintaining momentum on the issues, I would like to suggest moving ahead with another round of alternative bait trials involving those states interested in participating, whoever they may be. But instead of trying to pull this off

this fall, which I think was an initial idea. It now seems evident that a better approach would be to suggest doing this next year in 2017. That would give the board time to design the study, really through the TC of course. Design the study, determine participation, determine cost and available funding sources; and bring the whole package back before the board for review and approval prior to implementation.

In chatting to Kirby about it he brought up the very good point that this might actually sync well with the assessment, so that it would be reported out in 2018, which is when the assessment is going to be undertaken as well. With that I did prepare a motion to just sort of move forward along the lines of what I just indicated; and I think staff will bring that up.

Again the point being to try to move forward, but not to do it until 2017, the key caveat as I think you'll see reflected is that Toni reminded me that this would need to be folded in. If the board agrees to do this, to task the TC, it would need to be folded into the action plan for next year; that is an October, 2016 issue. I would therefore, and I will read this motion now into the record.

Move to task the Technical Committee with designing bait experiments to be completed in 2017, for those states that opt to participate, involving reduced amounts of horseshoe crab relative to status quo in the whelk and eel fisheries, to be developed for board review and approval by October, 2016.

CHAIRMAN GILMORE: Second to the motion; Brandon Muffley. Discussions on the motion. Adam Nowalsky.

MR. ADAM NOWALSKY: I am guessing that with this motion we have a firm commitment from at least Rhode Island to go through with those trials, asking the TC to design something for those states that opt to participate, would it be helpful to the TC to know how many states they're looking at. I would think that would be part of the design process. That would be the one concern I have with this is giving them some direction here in who those states might be.

CHAIRMAN GILMORE: That is a good point, Adam. Assuming Rhode Island would be interested; how about by a show of hands how many states would consider this. We've got at least five states that are interested in doing this. I think that would be a worthwhile endeavor. Do you agree, Adam?

MR. NOWALSKY: It's up to the board.

CHAIRMAN GILMORE: Any other questions before we vote on this motion, or comments? Go ahead, Toni.

MS. KERNS: You know, I think that the main reason for wanting to know the states is that way it will help us develop a budget a little bit better, in order to include that into the action plan; depending on location, et cetera, will help us get information from the bait supplier and how much it would cost to get bait down to the different states.

CHAIRMAN GILMORE: You want to get the specific states, go that way?

MS. KERNS: We'll reach out in an e-mail to determine to the full board, and get at least commitment that you are interested in participating, so that we can develop a budget based on that.

CHAIRMAN GILMORE: Any other comments? **Okay, all those in favor of the motion please raise your hand; opposed, null votes, abstentions; passes unanimously.** That is the last item we have. Is there any other business to come before the Horseshoe Crab Board?

ADJOURNMENT

CHAIRMAN GILMORE: Seeing none; I will exercise my right as a chair to adjourn us. We are adjourned.

(Whereupon, the meeting was adjourned at 4:25 o'clock p.m., August 2, 2016.)

Atlantic States Marine Fisheries Commission

1050 N. Highland Street • Suite 200A-N • Arlington, VA 22201
703.842.0740 • 703.842.0741 (fax) • www.asmfc.org

MEMORANDUM

October 6, 2016

To: **Horseshoe Crab Management Board**

From: **Kirby Rootes-Murdy, FMP Coordinator**

RE: **Recommendations on 2017 Harvest Specifications for the Delaware Bay Region**

This memo summarizes the annual harvest recommendations made by the Adaptive Resource Management (ARM) Subcommittee, Horseshoe Crab Technical Committee, and Delaware Bay Ecosystem Technical Committee.

The ARM Subcommittee met by conference call on September 16th, 2016 to discuss data inputs to the ARM Framework for 2017 specifications. Since the ARM Framework was approved for management through Addendum VII in 2012, data from the Virginia Tech Trawl Survey (VT Trawl) was specified to provide abundance estimates for horseshoe crab in the model. However, due to a lack of funding, the VT Trawl Survey has not been conducted since 2013, so no data exist from 2012 to present. Last year, the ARM Subcommittee decided to use a composite index comprised of information from 3 other trawl surveys (Delaware DNREC 30 ft trawl survey, the New Jersey DFW Delaware Bay trawl survey, and NJ DFW Ocean trawl survey) that take place in the Delaware Bay Region and was used again this year. This composite index was then compared to the VT trawl survey time-series data, and a linear regression analysis was conducted to make sure that composite index tracked the same trend and scale of the VT trawl survey. For the Red Knot stopover population estimate in the Delaware Bay Region, a mark-resight sampling approach was used to evaluate data collected in Delaware and New Jersey from May through June each year. This approach has been used since 2011.

Monitoring Data

Sources of data for horseshoe crab abundance and mark-resight estimates for red knot abundance are described above. Male and female horseshoe abundance in 2015 were 16.4 million and 8.1 million crab, respectively. Red knot abundance is estimated at 47,254 birds for 2016 (95% Confidence Interval for the stopover population is 44,873-50,574).

Table 1: Horseshoe crab and Red Knot abundance estimates for the Delaware Bay Region.

Horseshoe crab abundance (millions)			Red knot abundance (×1,000)	
Year	Male	Female	Year	Male and female
2015 (Fall)	16.4	8.1	2016 (Spring)	47.25

Harvest Recommendations

The monitoring data listed above was inputted into the ARM model and the optimized harvest package selected for 2017 was harvest package #3 (500,000 male horseshoe crab only). The ARM Subcommittee recommended harvest package #3 be used for 2017 harvest specifications. The harvest packages used in the ARM framework are shown in Table 2.

Table 2: Harvest packages and associated harvest numbers. 2017 recommended package (#3) is in bold.

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

On October 5th, 2016 the Horseshoe Crab Technical Committee and Delaware Bay Ecosystem Technical Committees (TCs) reviewed and endorsed the ARM Subcommittee's recommendation on harvest specifications for 2017. Based on the recommended harvest package from all three groups, the 2017 Quotas for the Delaware Bay Region states are outlined in Table 3.

Table 3: 2017 Quotas for Delaware Bay Region States based on ARM Subcommittee and TCs recommendation

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

*Virginia harvest refers to harvest east of the COLREGS line only

Please contact myself or Mike Schmidtke, FMP Coordinator for Horseshoe Crab (mschmidtke@asmfc.org ; 703-842-0740) with any questions about the ARM framework or specifications-setting process.

Atlantic States Marine Fisheries Commission

Horseshoe Crab Adaptive Resource Management Subcommittee

Call Summary

Friday September 16, 2016
1:30 - 3:30 p.m.

Attendees

John Sweka (USFWS), Jim Lyons (USGS), Audrey DeRose-Wilson (DE DNREC), Dave Smith (USGS), Ed Hale (DE DNREC), Conor McGowan (USGS/Auburn University), Joe Smith for Larry Niles, Wendy Walsh (USFWS), Jeff Brust (NJ DFW), Steve Doctor (MD DNR)

ASMFC Staff: Mike Schmidtke, Kristen Anstead, Kirby Rootes-Murdy

1) **Update from the ASMFC Board Meeting (August 2016) and follow up tasks**

- Kirby went over the Board meeting and highlighted for that 2017 harvest specifications, the group will simply do a 'turn of the crank' of the 'old' ARM model (not incorporating any biomedical information or alternative harvest packages.)

- Kirby introduces Mike Schmidtke as the new FMP Coordinator for Horseshoe Crab and that the two of them will be working together over the next couple of months as Mike is on-boarded

2) **Consider Survey data updates for Horseshoe Crab Composite Index & Discussion**

- John Sweka presented his update of the composite index work- he points out that there have been some changes from the document he circulated.
  - Last year, there was no new Virginia Tech (VT) trawl survey data so the ARM Subcommittee came up with this method of taking 3 other trawl surveys (DE 30' ft, NJ Ocean, NJ Delaware Bay) and created a composite index of relative abundance. This composite index was then compared to the VT trawl survey time-series data, and a linear regression analysis was conducted to make sure they were tracking the same trend and scale. Additionally, the composite index was calibrated to the years of overlapping data to extrapolate to a total population estimate.
  - As stated earlier in the meeting, this year is a turn of the crank of the ARM model regarding model inputs – Jeff Brust & Jordy Zimmerman gave him the trawl data and he ran the model.
    - Male and Female crab abundance went up in composite index for both species went up a little bit, 16.4 M and 8.1 F (million crabs)
    - All 3 surveys are weighted equally in the model, John is willing to send the R code around

- John isn't concerned that it has been a few years since we had the VT survey to compare the composite index numbers to since we are in the same scale.
- John points out that after this year, worst-case scenario is we have one more data point from the VT Trawl Survey for updating the composite index and continue to use the composite index into the future.

- Kirby asks that in the event we don't have continual funding for the VT trawl survey beyond 2016, could New Jersey and Delaware adjust their surveys to collect more bio-samples on Horseshoe Crabs- specifically the pre & post spawning marks, etc.?
  - Jeff Brust says it would be doable to take more HSC data in their trawl surveys, they've added additional sampling before and if it doesn't take that long it is probably possible, but he makes no promises. Ed Hale agrees for the DE survey-possible, but no guarantees yet
  - Wendy Walsh agrees with using the composite index this year and is happy about further calibration with the VT survey running this year and she likes that NJ DFW and DE DNREC are willing to add additional biosampling for horseshoe crabs into their surveys. But she points out that if the composite index is going to be the more permanent data source for horseshoe crab abundance moving into the future, she'd like to revisit it (i.e. if VT trawl doesn't continue in the future) more thoroughly and have a further review by the ARM Subcommittee
    - Conor McGowan agrees with a more formal assessment of the composite index but says they did a pretty thorough assessment for HSC and it is going to really hard- the number of crabs you need to tag is around millions so what we have here is a really useful approach for now

- Dave Smith – what are you asking what the biosampling request is for the state surveys just discussed- Pre-recruits? Because than that would allow for the Catch Survey Analysis (CSA) to get at catchability.
  - Yes, that is what Kirby was speaking to.

- Additionally, Dave asks whether John Sweka looked at the sex ratio on the composite index? Because as the harvest is skewed to male, one indirect result would be a change in the sex ratio that we really haven't seen.
  - John said he hasn't formally looked at it but he could look at it further and put it in the report – sex ratio from the composite index over time. Conor McGowan asks for clarification about what has been observed in the sex ratio in the composite index
    - John says just looking at the raw numbers they appear similar. Except for 2012.

- Kirby asks a clarifying question about what the 'terminal' year is that goes into the ARM Model that the HSC abundance index is a year behind the shore birds, i.e. 2015 for HSC and 2016 for birds.
  - John outlines that was because a difference in timing for when the surveys were conducted, that this was examined when the model was set up, and that the thinking was, given when the harvest occurs for HSC after they spawn in the summer, the VT

survey occurs in the fall and that was indicative of what would be left to produce eggs for the next year

- Conor adds that some of the simulation work that Dave Smith led in 2013 applied ecology paper didn't directly deal with the time lag issue but that simulated work showed that the time delay was ok for our decision making

3) **Consider Survey data updates for Red Knot super population estimate & Discussion**

- Jim Lyons goes over table 4 in the report he sent out to the group, that outlines population estimates, but won't go over the summary of the migration. In summary, fewer flagged birds detected this (2016) year; the 2016 estimates is closer to 2014 & 2013 than 2015 when it was much bigger.
  - Jim also tried to address some of the conversations the ARM Subcommittee and Delaware Bay Ecosystem Technical Committee have had about the fluctuations in estimates between the aerial survey and the ground survey. In general, the aerial survey went down a little bit so the ratio for these two things is a little higher than average.
  - 2015 did seem to be a good year for birds with independent evidence, more birds reaching the high body weights than other years, an early moon (full) in migration period, water temps were warm, so there may have been earlier and more spawning in 2015 that led to good foraging conditions – not the ultimate reason the approximate thing is that more of the fly population stops in Delaware Bay – the number of birds we see in the passage population but it is largely determined by the proportion that stop in Delaware Bay in his opinion, and 2015 was a good year.
    - Conor McGowan – so that is an interesting point, is there any effort to talk to the Virginia bird survey people (Brian Watts in VA); Jim said he has not talked to them, but we could reach out and see if there is something they can share
    - Wendy Walsh– her recollection is that there is some movement between Georgia and Virginia and Delaware Bay in years but not a whole lot, they tend to pick one or another
    - Kirby asks if the birds stopover in Virginia and they do so instead of the Delaware Bay (at least where the volunteers are sampling in DE & NJ) why don't we account of those estimates from this since it is part of the ARM model?
      - Jim doesn't think we need to combine the Delaware Bay and Virginia estimate, not going to get a real formal estimate for those two places, but the idea of looking at data from outside of the bay in the other places and incorporate into super-population estimates. Additionally, there doesn't appear to be any birds missed- at worst, you may be double counting birds if you combine estimates from both areas.
      - Conor says the red knots that use the Delaware Bay is the core objective of ecosystem integrity for the ARM model.
    - Steve Doctor asks whether the number of birds tagged each year are consistent or increasing or decreasing.
      - Jim says it may have gone down in recent years and but that they shoot for something around 800-1000 birds a year.

- Audrey DeRose-Wilson says it was down but the number of birds was down too, so relative to the number of individuals we see in a day, we were happy with the size of catches we were making but it was less and more difficult

- Regarding the previous question, Kristen asks about the horseshoe crab composite index accounts for crabs caught off of New Jersey, Delaware, and Maryland, but that the Red Knots are only counted from New Jersey and Delaware.
  - ♦ Conor & John offer that the horseshoe crab spawning population overwinters offshore in those states, so the area of the trawl survey that spawns mostly in the Delaware Bay
- Kirby asks about the peak count index – it went down this year, but the previous 4 were higher and steady
  - ♦ Jim says that this is from an aerial survey on one day and it is supposed to be the peak, this number also reflects turnover in the pop and the peak number doesn't account for that, the number of birds detected in one day
- Lastly, Kirby asks about the Confidence Interval changes for the population estimates- in 2015 to 2016, which were very different
  - ♦ Jim says it's an uncertainty of all the numbers-when there is a lot of uncertainty in detection rates that translates right into uncertainty about the population sizes, probability of detection changes the most from year to year.

<u>Conor presents results from the ARM model:</u>

❖ Conor used the information sent around (by Jim and John) ahead of the call to input into the ARM Model to see what the optimized harvest package is for 2017
  - Based on the latest year's data, the optimized **<u>harvest package is #3 (500,000 male crab only)</u>**

➢ The group discusses the data and whether other members of the ARM Subcommittee would be able to review the harvest output through the Model
  - Conor points out the data file it draws from is huge, so it can't be emailed or put in dropbox but could send the code or look into FTP
  - John points out that the R script and data file isn't running the optimization- that is being run on ASPD

➢ ***The ARM Subcommittee is in agreement with the optimized harvest package 3 (500,000 male crabs) for 2017 in the Delaware Bay Region (for the States of New Jersey, Delaware, Maryland, and Virginia)***

4) **Consider Board motion and developing draft Addendum VIII options**

❖ Kirby goes over a draft decision tree for the draft addendum regarding mortality associated with biomedical activities- ASMFC Staff currently understands the motion made at last month's Board meeting is to have the addendum set up as a set of decision points, that builds off of an initial decision on how to treat biomedical mortality….The current challenge with

moving forward and developing the addendum, is that there is concern in taking the document out to the public without understanding how biomedical mortality- let alone alternative harvest packages- would affect the optimized harvest package in the ARM Model. Specifically, we may create a lot of confusion if the public provides comments and indicates preference for a new set of ways for accounting for biomedical mortality and harvest package options-with the assumption that it will lead to a certain harvest output- but that we don't really know how the ARM Model will treat these changes.

- So to address this concern, ASMFC staff is trying to get a sense of how quickly the group could go through 'sensitivity analysis' of at least two scenarios- the (1st would be using the ARM Subcommittee's preferred method for treating biomedical mortality (subtracting it from the current harvest packages) going back through the last 5-10 years and plugging the terminal year data in and seeing what the optimized harvest package would be; the (2nd would be doing the same thing with the secondary/minority option for accounting biomedical mortality (applying it as an additional population level mortality in the population dynamics model) and seeing what the optimized harvest package would be. For the timetable, ASMFC Staff wants to see how reason it would be do this 'sensitivity analyses' before the Annual Meeting, or before the Winter Meeting in February 2017, etc.
- Conor and John offer that the model is run using ASDP software, C+++, R script, and that it would take a bit of work to try and complete this in the short term.

- John says basically the Board wants to see how this will affect the harvest packages
  - Kirby says yes, but the Technical Committees, including the ARM Subcommittee serve at the will of the Board, the group can offer the opinion though

- Many members of the ARM Subcommittee raise concerns about the timeline and the runs, etc. Additionally, folks wants to be clear what the comparisons be against
  - Kirby offers up the comparisons should be against what the optimized harvest package would be without biomedical mortality taken into account. In pushing on the timetable, Conor offers that the #1st scenario could be completed fairly quickly (just a couple pf weeks) the #2nd scenario would take longer, likely not able to be done by February 2017 Meeting. The reasoning for the delay on the #2nd scenario is that there are multiple iterations that could be run under different assumptions.

- Kirby offers up what the example biomedical mortality (approximately 34K crabs- 15K females, 22K males) would be in Delaware Bay region for adjusting harvest packages and for inputting in the population dynamics model
  - Without any analysis, anecdotally ARM Subcommittee members think that with numbers around 34k (a 'negligible number'), it probably won't change optimized harvest package. The reason why the magnitude of biomedical take is is very small compared to the magnitude of the abundance bins.
  - On a separate but related point, John offers that harvesting of female crabs when you are below the abundance threshold will just delaying the time until you can have more Female harvest

- Under what conditions females are valued, we are under the threshold, taking the Female crabs out takes away her contribution and it would be one less female to grow to 11.2 Females (current female abundance threshold) where you can have value on the female crabs

❖ ASMFC Staff points out that this raises questions and creates confusion on why a comparable level of female bait harvest would not be allowed under the ARM Model, as that has been an active goal for Board members.
  - ARM Subcommittee members bring up the point that again, the thresholds are directing the model to select a harvest package that doesn't put additional stress on the female crab population….because they are below the thresholds.

❖ Steve Doctor offers that the draft addendum maybe shouldn't go forward given these considerations. Additionally he offers up the follow questions:
  - When we do our harvest packages, we add additional crabs for MD and VA and why isn't it important to include them?
    - The level of harvest is not significant and are assumed to be non-Delaware Bay horseshoe crabs.
  - Can they take some of that and make it Female harvest? What if we took them South of Ocean City (MD) inlet?
    - Possibly, but it would be on Maryland to demonstrate how they would likely not be Delaware Bay origin crabs
  - Does the red knot and the female horseshoe crab threshold both have to be exceeded for Female horseshoe crab harvest packages to be the optimized harvest package output?
    - No, it's either/or.

5) **Next Steps** (*K. Rootes-Murdy*) 3:15-3:30 p.m.

❖ Wendy provides the group with a general update on where US FWS is with developing consultation for sections of the ESA. Kirby asks if she could provide this overview to the Horseshoe Crab TC and DETC next month
  - She can & will

❖ The draft call summary will be sent around for the group to provide comment on

❖ Kirby will look into the FTP site size/space for sharing ARM Model components & share with the group

❖ The draft call summary and ARM Subcommittee recommendation for 2017 harvest specifications will be sent to the TCs for their consideration

❖ Kirby, Mike & Kristen will follow up with the group to formalize what the timetable is for completing the sensitivity analysis to report to the Board at the Annual Meeting

Adult Horseshoe Crab Abundance in the Delaware Bay

Delaware Bay ARM Workgroup

Report to the Delaware Bay Ecosystem Technical Committee

September 16, 2016

Introduction

In 2015, the Adaptive Resource Management (ARM) workgroup developed a horseshoe crab abundance index based on three trawl surveys in the Delaware Bay region: Delaware 30 foot trawl survey, the New Jersey Delaware Bay trawl survey, and the New Jersey Ocean trawl survey. This composite index was developed because the Virginia Tech trawl survey, which was used to estimate horseshoe crab abundance, lost funding and did not occur. The ARM workgroup showed that the composite index from the three other trawl surveys correlated well with the Virginia Tech Trawl survey for years in which data overlapped and could be used as a substitute for the Virginia Tech Trawl survey when estimating the abundance of male and female horseshoe crabs. This report adds data collected in 2015, updates the composite index, and extrapolates the composite index to horseshoe crab abundance for harvest recommendations to be implemented in 2017.

Methods

Relative abundance data from the Delaware 30 foot trawl survey, the New Jersey Delaware Bay trawl survey, and the New Jersey Ocean trawl survey were used as input to a linear mixed random effects model to generate the composite index for each year from 1998 – 2015. In this model, each individual survey within a year represented the random effect. The model was fit using the "lme" function from the package "nlme" in R 3.0.2 and was specified as a non-intercept model to allow for year specific estimates of abundance rather than differences for each year from the intercept. Index values from each survey were ln + 0.01 transformed prior to model fitting and final yearly indices of abundance from the model were back-transformed.

Linear regression models relating the composite indices of abundance for each sex to the total abundance estimates from the Virginia Tech trawl survey were used to extrapolate total abundance of male and female horseshoe crabs in 2015. Regression model parameters are presented in Table 1.

Results

The relative abundance indices for both males and females from the New Jersey Ocean Trawl and the New Jersey Delaware Bay trawl both increased in 2015 over what was observed in 2014 for both sexes. However, relative abundance from the Delaware Bay 30 foot trawl decreased from 2014 to 2015 for both sexes. When combined into the composite index of abundance, the result was a slight increase from 2014 to 2015 (Figure 1).

Sex ratios (males:females) from the compsosite index have varied through the time series and were lowest in the first two years (1998 – 1999). Since 2000, the sex ratio has ranged between 1.06 and 1.69 (Table 3).

Final estimates of total abundance for each sex are shown in Table 3 and Figure 2. The estimated abundance increased slightly for both sexes from 2014 to 2015 and remained among the highest values seen in the time series. Estimated adult abundance of horseshoe crabs in the Delaware Bay region was 16.4 million males and 8.1 million females in 2015.

Table 1. Regression parameters relating the composite index of abundance to the estimated abundance from the Virginia Tech trawl survey (2002 – 2011).

Regression parameter	**Males**	**Females**
Intercept	3498342 (S.D. = 3353432)	2120198 (S.D. = 2285174)
Slope	26277569 (S.D. = 9520073)	15443844 (S.D. = 9346638)
p-value (Slope)	0.025	0.137
R^2	0.488	0.254

Table 2. Relative abundance index values from three trawl surveys in the Delaware Bay region and the composite abundance index derived from the three trawl surveys.

Sex	Year	Delaware 30 ft. trawl	NJ DE Bay trawl	NJ ocean trawl	Composite Index
Male	1998	0.34	0.29		**0.32**
	1999	0.42	0.17	0.50	**0.33**
	2000	0.75	0.33	0.45	**0.48**
	2001	0.57	0.18	0.27	**0.31**
	2002	0.07	0.25	0.32	**0.18**
	2003	0.82	0.18	0.44	**0.41**
	2004	0.02	0.19	0.47	**0.13**
	2005	0.06	0.46	0.56	**0.26**
	2006	0.68	0.30	0.47	**0.46**
	2007	1.04	0.58	0.27	**0.55**
	2008	0.20	0.42	0.24	**0.27**
	2009	0.41	0.21	0.28	**0.29**
	2010	0.36	0.53	0.21	**0.34**
	2011	0.43	0.42	0.39	**0.41**
	2012	0.23	0.34	0.32	**0.29**
	2013	0.09	0.47	0.53	**0.29**
	2014	1.19	0.17	0.44	**0.45**
	2015	0.68	0.32	0.55	**0.49**
Female	1998	0.47	0.21		**0.40**
	1999	0.63	0.11	0.52	**0.33**
	2000	0.65	0.19	0.47	**0.39**
	2001	0.89	0.10	0.25	**0.28**
	2002	0.08	0.11	0.43	**0.16**
	2003	0.71	0.05	0.48	**0.26**
	2004	0.04	0.07	0.59	**0.12**
	2005	0.10	0.24	0.51	**0.23**
	2006	0.75	0.08	0.51	**0.32**
	2007	0.83	0.24	0.29	**0.39**
	2008	0.18	0.09	0.31	**0.17**
	2009	0.27	0.10	0.30	**0.21**
	2010	0.12	0.26	0.26	**0.20**
	2011	0.19	0.18	0.52	**0.26**
	2012	0.23	0.16	0.41	**0.25**
	2013	0.02	0.27	0.67	**0.17**
	2014	0.83	0.13	0.44	**0.37**
	2015	0.47	0.18	0.55	**0.39**

Table 3. Sex ratios (male:female) of horseshoe crabs from the composite index in the Delaware Bay region.

Year	Male Index	Female Index	Sex Ratio
1998	0.32	0.40	0.80
1999	0.33	0.33	0.99
2000	0.48	0.39	1.23
2001	0.31	0.28	1.08
2002	0.18	0.16	1.11
2003	0.41	0.26	1.55
2004	0.13	0.12	1.06
2005	0.26	0.23	1.09
2006	0.46	0.32	1.45
2007	0.55	0.39	1.41
2008	0.27	0.17	1.57
2009	0.29	0.21	1.41
2010	0.34	0.20	1.69
2011	0.41	0.26	1.59
2012	0.29	0.25	1.17
2013	0.29	0.17	1.68
2014	0.45	0.37	1.20
2015	0.49	0.39	1.27

Table 4. Estimates of total abundance of horseshoe crabs in the Delaware Bay region derived from the composite index (1998 – 2015) of abundance and the Virginia Tech trawl survey (2002 – 2011).

Sex	Year	Composite Index	Virginia Tech
Male	1998	11,807,094	
	1999	12,089,616	
	2000	16,169,464	
	2001	11,555,142	
	2002	8,170,110	10,580,000
	2003	14,143,996	7,070,000
	2004	6,933,445	6,500,000
	2005	10,229,999	9,250,000
	2006	15,622,016	17,490,000
	2007	17,924,041	20,490,000
	2008	10,693,529	15,770,000
	2009	11,112,324	7,060,000
	2010	12,497,038	12,470,000
	2011	14,393,501	15,040,000
	2012	11,128,639	
	2013	11,004,110	
	2014	15,195,798	
	2015	16,408,173	
Female	1998	8,240,393	
	1999	7,217,570	
	2000	8,150,712	
	2001	6,501,516	
	2002	4,594,430	5,450,000
	2003	6,148,223	3,580,000
	2004	4,016,565	2,990,000
	2005	5,745,271	4,400,000
	2006	7,046,331	7,900,000
	2007	8,116,324	9,530,000
	2008	4,812,232	9,480,000
	2009	5,290,044	3,750,000
	2010	5,241,762	5,280,000
	2011	6,148,819	4,800,000
	2012	5,950,225	
	2013	4,741,787	
	2014	7,853,763	
	2015	8,088,111	

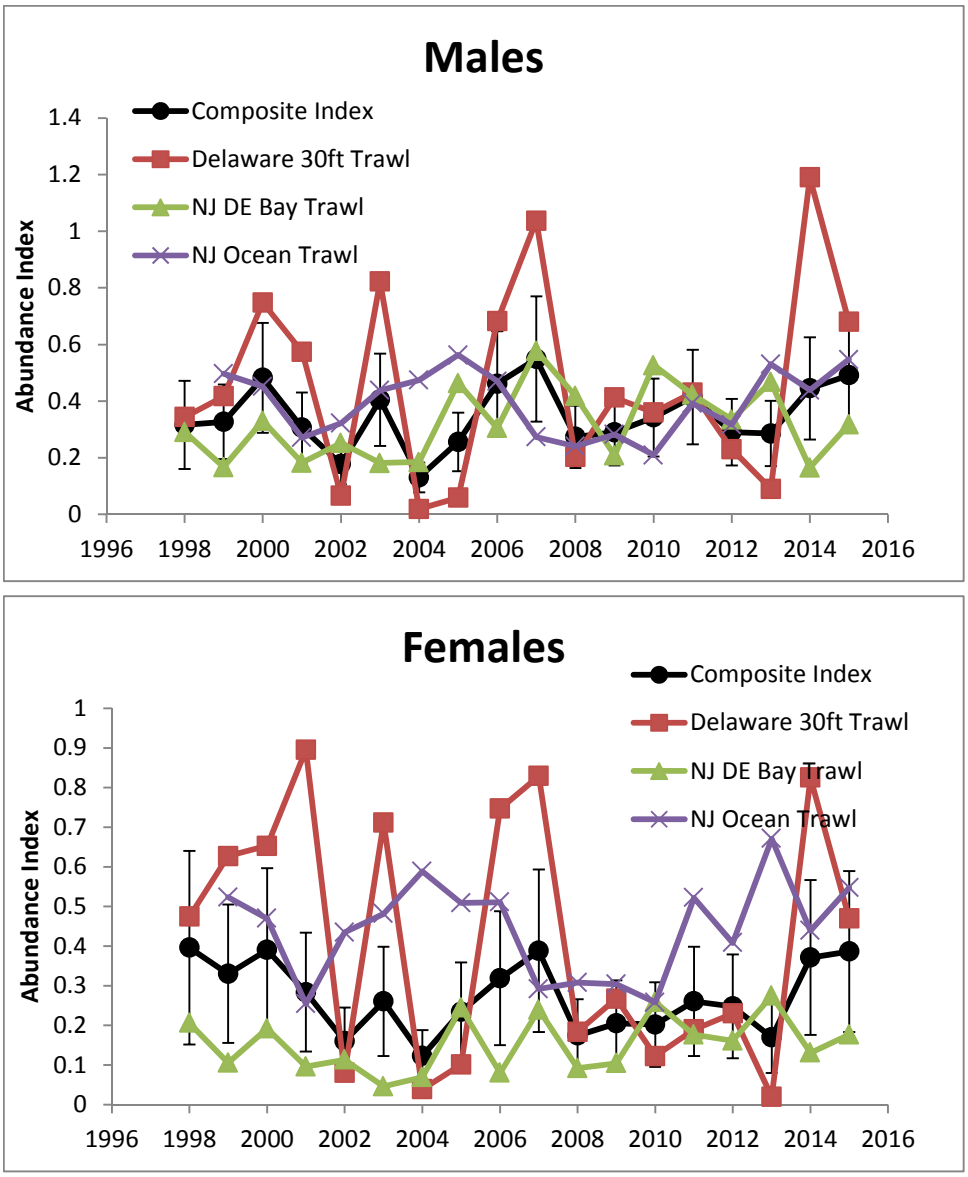


Figure 1. Comparison of the composite index of abundance from the linear mixed random effects model and the individual trawl surveys used to derive the composite index of abundance.

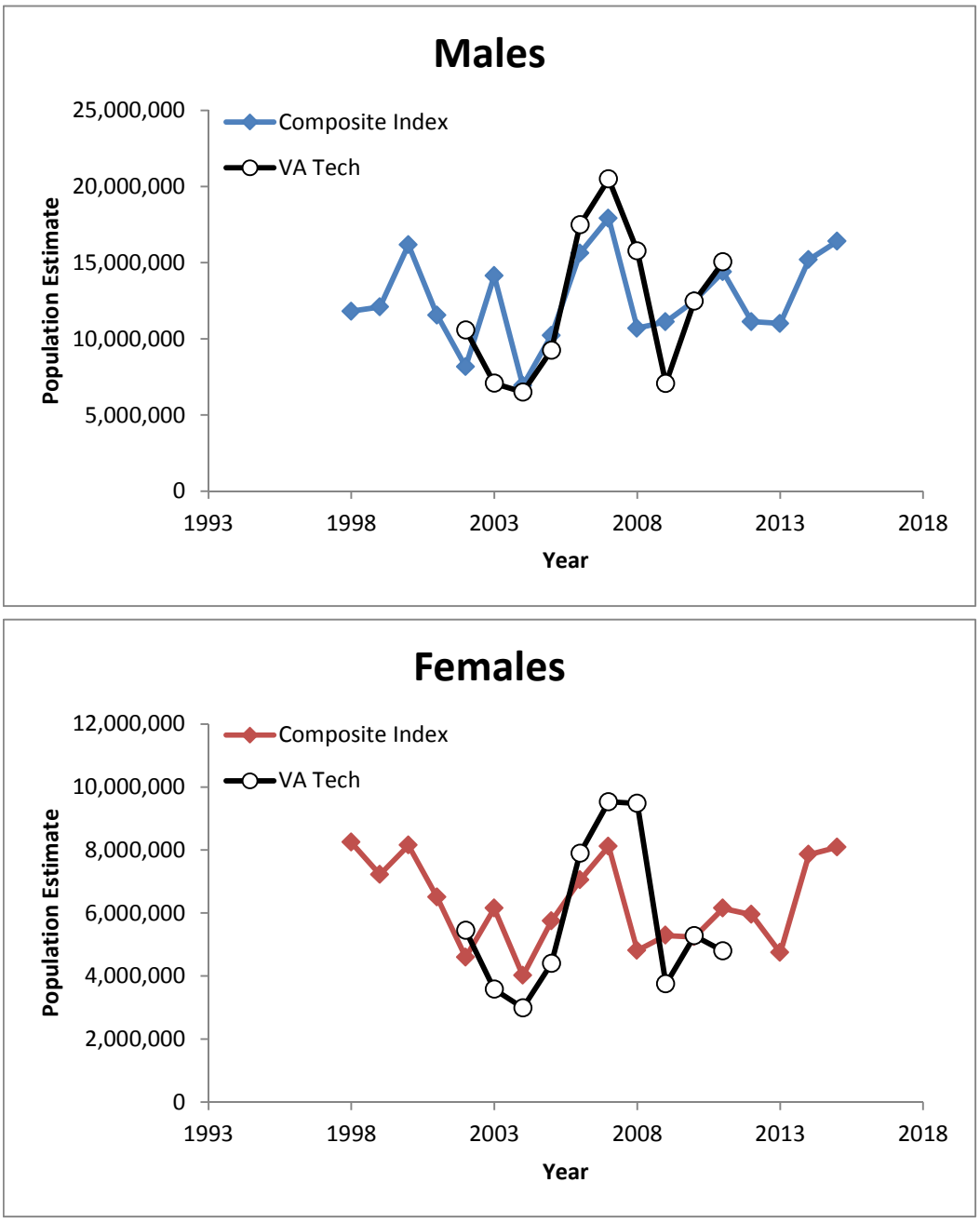


Figure 2. Time series of horseshoe crab population estimates derived from the composite index (1998 – 2015) and the Virginia Tech trawl survey (2002 – 2011).

MEMO

To: Delaware Bay ARM Working Group
From: Jim Lyons, USGS Patuxent Wildlife Research Center, Laurel, MD
Re: Red Knot Stopover Population Estimate for 2016
Date: 26 August 2016

1 Acknowledgments

We thank the many volunteers in Delaware and New Jersey who collected mark-resight data in 2016. We are grateful to A. DeRose-Wilson (Delaware DFW) and A. Dey (New Jersey ENSP), and volunteers in Delaware and New Jersey for data entry and data management, and L. Usyk (bandedbirds.org) for data management.

2 Methods

Mark-resight data and counts of marked and unmarked birds were conducted according to the methods for mark-resight investigations of Red Knots in Delaware Bay (Lyons 2016). Red knots have been individually marked with engraved leg flags in Delaware Bay and other locations for many years; each leg flag is engraved with a unique 3-character alphanumeric code (Clark et al. 2005). Surveys to locate flagged birds were conducted on each beach every three days according to the sampling plan (Table 1). During these resighting surveys, agency staff and volunteers recorded the alphanumeric combinations on leg flags for birds that were detected. While searching for birds marked with engraved leg flags, observers also periodically use a scan sampling technique to count marked and unmarked birds in randomly selected portions of Red Knot flocks (Lyons 2016).

Table 1. Dates for mark-resight sampling occasions (3-day periods) in Delaware Bay.

Sample	Dates	Sample	Dates
1	≤10 May	6	23-25 May
2	11-13 May	7	26-28 May
3	14-16 May	8	29-31 May
4	17-19 May	9	1-3 June
5	20-22 May	10	≥4 June

As in previous years, all flag codes that were detected were validated with banding data available in the data repository bandedbirds.org, except for orange engraved flags (Argentina). As in previous years, all resightings of orange engraved flags were included in the analysis because banding data from Argentina are generally not available in bandedbirds.org.

We used the mark-resight data and data from the scan samples of the marked-ratio to estimate stopover population size using the methods of Lyons et al. (2016). In this "superpopulation" approach, passage population size is estimated using the Jolly-Seber model for open populations to account for the flow-through nature of migration areas and probability of detection during surveys.

In the analyses for Delaware Bay, the days of the season were aggregated into 3-day sampling periods, the same sampling periods used in prior analyses (a total of 10 sample periods possible each season, Table 1). Data are aggregated to 3-day periods because this is the amount of time necessary to complete mark-resight surveys on all beaches in the study. In 2016, few observations were available for period 10 (i.e., ≥4 June) so the 2016 analysis was restricted to 9 sampling periods (data summary provided in Appendix 3).

In the mark-resight superpopulation approach we estimate the number of birds that are carrying leg flags, and then adjust this number using the estimated proportion of the population with flags to account for unmarked birds. The estimated proportion with leg flags is thus an important statistic. We estimated the proportion of the population that is marked from the scan sample data (counts of marked birds and the number checked for marks) and a binomial model. To account for the random nature of arrival of marked birds to the bay and the addition of new marks during the season, we implemented the binomial model as a generalized linear mixed model with a random effect for the sampling period. More detailed methods are provided in Lyons et al. (2016) and Appendix 4.

3 Summary of Mark-resight and Count Data Collected in 2016

Mark-resight encounter data.—The Red Knot mark-resight database for 2016 contained a total of 3,510 individual birds that were seen in Delaware Bay at least once in 2016. This number is approximately 20% fewer individual birds than were seen in 2015 (4,353 birds; Appendix 1). Birds from five countries were detected in Delaware Bay in 2016 (Table 2).

Table 2. Number of flags detected by banding location (flag color).

Banding location (flag color)	No. flagged individuals detected
U.S. (lime green)	2,341 (67%)
U.S. (dark green)	617 (18%)
Argentina (orange)	323 (9%)
Canada (white)	166 (5%)
Brazil (dark blue)	32 (<1%)
Chile (red)	31 (<1%)
Total	3,510

Marked-ratio data.—Seven hundred and seventy-seven (777) marked-ratio scan samples were collected in 2016: 299 samples in Delaware and 478 in New Jersey (Appendix 3). Marked-ratio data were collected between 7 May and 5 June 2016, with much more even sampling across the season than in 2015 (Appendix 2). Field crews collected 260% more scan samples in 2016 than in 2015, when 298 marked-ratio samples were collected.

Aerial and ground count data.—Aerial surveys were conducted on 23 and 26 May. A. Dey compiled the aerial and ground survey data (Table 3). Complete ground counts were made on the same days that aerial surveys were conducted (Table 3).

4 Summary of 2016 Migration

Arrivals to the bay peaked on or about 18 May, when approximately 28% of the stopover population arrived. Smaller numbers arrived in each of the sampling occasions leading up to 18 May: approximately 18% of the population arrived on or about 12 May and another 15% on or about 15 May (Fig 1a). Unlike 2014 and 2015, relatively few birds arrived in the later stages of the migration season in 2016. In 2014, for example, a relatively large proportion of the stopover population (about 25%) arrived during 23-25 May, i.e., late in the season given typical departure dates. Similarly, in 2015 a late wave of arrivals between 23 and 28 May accounted for approximately 26% of the population. In 2016, there was not a late wave of arrivals; most birds arrived before or during the 18 May sampling occasion.

Stopover persistence is the probability that a bird present in the bay during sampling occasion i is present in the bay at sampling occasion $i+1$. Estimated stopover persistence was relatively high (>0.85) until approximately 22 May (reflecting small amounts of turnover), and then declined steadily from 22 May until the end of the season. Following Lyons et al. (2016) we estimated stopover duration in 2016 was 12.3 days (95% CI 11.8–13.2 days), an estimate that accounts for probability of detection. The time between first and last sighting has been called "minimum length-of-stay." Minimum length-of-stay, which does not account for probability of detection, would suggest a much shorter length of stay (Appendix 5). Minimum length-of-stay has a negative bias because it does not account for the time present before first, and after last, day the bird was seen.

In 2016, mean probability of resighting across all 3-day sampling periods was 39% (95% CI 18-66%). Estimated resighting probability started off relatively high (50–60%) in early May but declined slightly as the season continued (Fig 1c). Resighting probability was below 40% for much of mid- to late-May 2016 (Fig 1c). In many previous years (2011–2014), estimated resighting probability often ranged from 40–70% throughout much of May in Delaware Bay.

The estimated proportion of the 2016 stopover population with marks (leg flags) was 0.099 (95% CI 0.092–0.106, Fig. 2), which is slightly greater than the 2015 estimate. As expected, the proportion marked was fairly steady throughout the season and did not fluctuate dramatically (Fig. 2). The estimated marked proportion in 2016 was similar to the years 2011-2014, when approximately 10-11% of the birds stopping in the bay carried leg flags.

5 Stopover Population Estimation

Fewer birds stopped in Delaware Bay in 2016 than in 2015. The stopover population for 2016 was estimated at 47,254 (95% CI 44,873 – 50,374). This superpopulation estimate accounts for turnover in the population and probability of detection. The 2016 superpopulation estimate is 22% lower than the estimate for 2015 (60,727; 95% CI 55,568 – 68,732) and similar to the 2014 estimate (44,010; 95% CI 41,900–46,310; Table 4).

The time-specific stopover population estimates in 2016 increased steadily during early May and peaked during 21-24 May at approximately 34,600 birds (Fig. 1d).

Annual fluctuations in stopover population size.—The annual fluctuations in the stopover population between 2014 and 2016 were the largest since mark-resight analyses began in 2011 (Table 4). Some ARM Subcommittee and Ecosystem TC members are concerned about the recent fluctuations in the estimates. While some of the change from year to year in the stopover population is a result of births and deaths (i.e., changes in the total population), these fluctuations in the stopover population are too large to be the result of births and deaths alone. Niles et al. (2008) noted similar fluctuations in the aerial surveys in Delaware Bay:

> "Until the late 1990s, the peak aerial counts in Delaware Bay were quite erratic from year to year (Fig. 32). Many of these changes are so big that they cannot have reflected changes in the total population because they are demographically impossible. Moreover, they are also far too large to be due to counting error. At this stage we can only speculate about the reasons. Possibly high availability of horseshoe crab eggs led to rapid turnover, leading to a reduction in the count; conversely bad weather may have prevented birds from departing leading to a build-up. It is also possible that in some years many birds exploited food resources, such as *Donax* or mussel spat, elsewhere along the Atlantic coast and did not visit Delaware Bay." – *Niles et al. 2008*

The changes in the stopover population between 2014 and 2016 were large but not unprecedented. Since 1989, aerial surveys in Delaware Bay have experienced a similar, or greater, year-to-year change in magnitude in five different years (see USFWS 2003, Dey et al. 2011). Niles et al. (2008) suggest that large annual fluctuations could be due to changes in stopover duration or changes in the proportion of the total population that visit Delaware Bay in any given year. Stopover duration did not vary substantially during the years 2014–2016, ranging from 10–12 days. The changes in the stopover population are more likely to be the result of fluctuations in the proportion of the total population that visits the bay each year.

Aerial surveys in 2016.—The aerial survey conducted on 23 May 2016 detected 21,128 birds, approximately 61% of the mark-resight estimate for the sample period 23-25 (Table 3, Fig. 1). The second aerial survey on 26 May 2016 detected 21,021 birds, which was within the 95% credible interval for the mark-resight estimate for the sample period 26-28 May (approximately 19,200–26,200 birds; Fig. 1).

Comparing mark-resight estimates and aerial surveys.—Some members of the ARM Subcommittee and the Ecosystem TC are concerned about the differences between mark-resight estimates and the aerial survey index. Here we review the types of estimates that result from the mark-resight superpopulation approach, briefly review the assumptions of the superpopulation approach (more details are available in Lyons et al., 2016 and Lyons 2016), and review the assumptions and concerns about the aerial survey data.

The mark-resight model estimates the number of birds that use the sampled beaches in Delaware Bay each year (i.e., the "stopover population size" or "superpopulation", N^*). This estimate accounts for turnover in the population during the migration season and probability of detection of marked birds during resighting surveys. Therefore, estimated superpopulation size will

always be greater than counts ("snapshots") from an aerial survey on any given day. The primary reason for the discrepancy between the superpopulation estimate (N*) and the peak count from aerial surveys (C) is population turnover.

The mark-resight model also produces time-specific population estimates (N_t) at 8-10 points during the season (depending on the amount of data available), and while not directly comparable to aerial surveys, it may be instructive to explore the discrepancy between these time-specific estimates and aerial survey indices.

The mark-resight data are aggregated before analysis into 3-day sampling occasions; three days is the length of time required to survey all beaches in the bay (Lyons 2016). Therefore, the time-specific estimates (N_t) are for the number of knots in the bay during a 3-day period, whereas the aerial surveys are completed in one day and represent the number of birds present on the day of the survey.

Nevertheless, the difference (D) between peak mark-resight estimate (N_t) and peak aerial count (C) each year, expressed as a fraction of the time-specific mark-resight estimate has ranged from 12% (in 2012) to 50% (in 2011) ($D = [\{N\_t - C\}/N\_t]*100$). The large discrepancy in 2011 may have been due to extenuating circumstances (observer illness during the survey); the second largest discrepancy was 39% (2016). The median discrepancy (D) during 2011-2016 was 30%.

The assumptions of the mark-resight superpopulation approach are described in detail in the Lyons (2016) and Lyons et al. (2016). One set of assumptions is that the rates of arrival, stopover persistence, and resighting are the same for all marked and unmarked individuals. Heterogeneity in resighting probability can cause bias in parameter estimates (Williams et al. 2002). The study design and sampling plan (Lyons 2016) has many elements that attempt to meet the assumption of homogeneity in resighting probability (e.g., regular, even sampling of the study area). Effects on parameter estimates of heterogeneity in stopover persistence are not well known. Some heterogeneity of stopover persistence may occur from data aggregation into 3-day periods for analysis. The average stopover duration in Delaware Bay is much longer than three days, however, so heterogeneity in stopover persistence from data aggregation should be small. Heterogeneity in stopover persistence may also occur from population structure and stopover-age effects, where stopover age is the amount of time since arrival to the stopover. There is some evidence that age-related variation in persistence does not affect parameter estimates when the amount of variation is small to moderate. Nevertheless, effects of heterogeneity in rate parameters from stopover age and population structure require additional research. See Lyons (2016) and Lyons et al. (2016) for a complete description of these and other assumptions of the mark-resight model.

The aerial surveys in Delaware Bay do not include corrections for bias of any sort. The surveyed area is not drawn from a sampling frame and the estimate is not extrapolated to any unsurveyed area. To the extent possible, pilots and aerial observers attempt to be consistent in the methodology and timing of the aerial survey to reduce errors of estimation. Nevertheless estimation errors may occur as a result of 1) counting errors, 2) imperfect detection of birds, and 3) availability of birds to be counted (Smith and Francis 2010).

Counting error is a type of estimation error in aerial surveys. Counting errors may be over- or under-estimates but there is ample evidence in the literature that observers tend to under-estimate

the size of large flocks of birds (Smith and Francis 2010). Observers also tend to under-estimate flocks of small birds more often than flocks of large birds.

Smith and Francis (2010) conducted simulation experiments with experienced observers and concluded that counting errors may result in population estimates that are approximately 25% too low, and that the magnitude of under-counts increased with flock size. Bigger flocks were under-estimated to a greater degree than small flocks. Undercounts of 12-32% were common (Smith and Francis 2010). It is perhaps coincidence that the median discrepancy between aerial surveys and mark-resight estimates (30%) was similar to these empirical measurements of counting errors. Nevertheless, there is ample evidence that undercounts are common even among experienced observers. The implications of under-counting errors should be acknowledged in a comparison of aerial surveys and mark-resight estimates.

Imperfect detection is another source of estimation error in aerial surveys. Counting large flocks of birds from the air is a difficult task and imperfect detection may result from poor visibility, inclement weather, identification, bird behavior, etc. Aerial surveys are generally conducted only in good weather conditions, but the Delaware Bay aerial survey protocol does not estimate probability of detection. Therefore it is difficult to assess the magnitude of detection errors, but it is important to remember that detection errors result in the counts being too low by some unknown amount.

Another error of estimation is related to "availability" to be counted; birds that are not in view of the aircraft are not available to be detected. The aerial survey covers most bay beaches used by knots but does not include the Atlantic coast of New Jersey (Niles et al. 2009), managed wetlands, and intertidal marshes; some birds use managed wetlands in Delaware (Niles et al. 2008) and marshes at high tide (Burger et al. 1997). Pilots and aerial observers make efforts to cover as much suitable habitat as possible during the aerial survey and be consistent from year to year, but it is impossible to survey all habitats and it seems that some fraction of birds in the bay are not available to be counted. The mark-resight estimate accounts for these birds if they visit the mark-resight beaches at some point during the season. The aerial survey estimate may be biased low due to availability but it is difficult to determine the magnitude of this error.

When all three sources of estimation error that are possible with aerial surveys – counting error, imperfect detection, and availability bias – are considered, almost all of which result in counts that are too low, the discrepancy between aerial survey data and mark-resight estimates may not be difficult to reconcile.

References

Burger, J., L. Niles, and K. E. Clark. 1997. Importance of beach, mudflat, and marsh habitats to migrant shorebirds on Delaware Bay. *Biological Conservation* 79:283-292.

Clark, N.A., S. Gillings, A.J. Baker, P.M. González, and R. Porter. 2005. The production and use of permanently inscribed leg flags for waders. Wader Study Group Bull. 108: 38–41.

Dey, A., L.J. Niles, H.P. Sitters, K. Kalasz, and R.I.G. Morrison. 2011. Update to the status of the Red Knot *Calidris canutus* in the Western Hemisphere, April 2011.

Lyons, J.E., W.P. Kendall, J.A. Royle, S.J. Converse, B.A. Andres, and J.B. Buchanan. 2016. Population size and stopover duration estimation using mark-resight data and Bayesian analysis of a superpopulation model. Biometrics 72:262-271.

Lyons, J.E. 2016. Study design guidelines for mark-resight investigations of Red Knots in Delaware Bay. Unpublished report. 13 pp.

Niles L. J., et al. 2008. Status of the Red Knot, *Calidris canutus rufa*, in the Western Hemisphere. Shipman (VA): Buteo Books, for the Cooper Ornithological Society. Studies in Avian Biology No. 36.

Niles, L. J., J. Bart, H. Sitters, et al. 2009. Effects of horseshoe crab harvest in Delaware Bay on Red Knots: are harvest restrictions working? Bioscience 59: 153-164.

Smith, P. and C. Francis. 2010. Environment Canada's monitoring of Red Knots in South America. Report to the Environment Canada Avian Monitoring Review. 19 pp.

U.S. Fish and Wildlife Service. 2003. Delaware Bay Shorebird-Horseshoe Crab Assessment Report and Peer Review. U.S. Fish and Wildlife Service Migratory Bird Publication R9-03/02. Arlington, VA. 99 p.

Williams, B.K., Nichols, J.D., and Conroy, M.J. (2002). *Analysis and Management of Animal Populations*. San Diego, California: Academic Press.

Table 3. Number of Red Knot detected during aerial and ground surveys of Delaware Bay in 2016. These data were provided by A. Dey, New Jersey Division of Fish and Wildlife, Nongame and Endangered Species Program.

	New Jersey	Delaware	Total
23 May 2016			
Aerial survey	20,360	768	21,128
Ground survey	18,104	1,857	19,961
26 May 2016			
Aerial survey	19,811	1,210	21,021
Ground survey	20,092	82	20,174

Table 4. Stopover (total) population estimate using mark-resight methods compared to peak-count index using aerial- or ground-survey methods. The mark-resight estimate of stopover population accounts for population turnover during migration; peak-count index does not account for turnover.

Year	Stopover population[a] (mark-resight *N**)	95% CI Stopover population *N**	Peak-count index [aerial (A) or ground (G)]	Ratio (*N**/Peak-count index)
2011	43,570	(40,880–46,570)	12,804 (A)[b]	3.40
2012	44,100	(41,860–46,790)	25,458 (G)[c]	1.73
2013	48,955	(39,119–63,130)	25,596 (A)[d]	1.91
2014	44,010	(41,900–46,310)	24,980 (A)[c]	1.76
2015	60,727	(55,568–68,732)	24,890 (A)[c]	2.44
2016	47,254	(44,873–50,574)	21,128 (A)[b]	2.23

[a] estimate for entire season, including population turnover
[b] 23 May
[c] 24 May
[d] 28 May

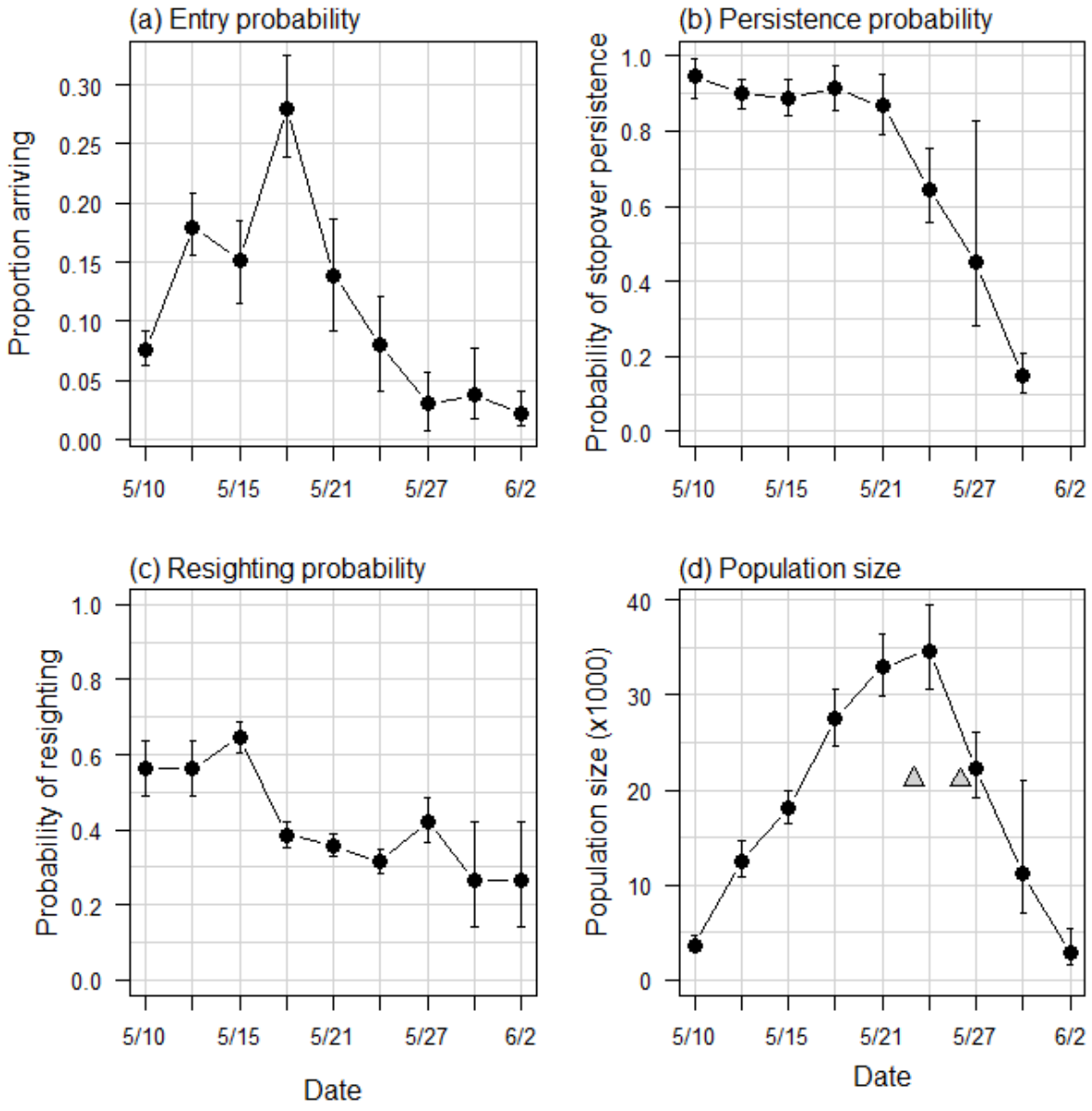


Figure 1. Estimated proportion of stopover population arriving in Delaware Bay at sampling points throughout the 2016 season (a), stopover persistence (b), probability of resighting (c), and time-specific stopover population size (d) from mark-resight analysis. Triangles in (d) are counts made by aerial survey (23 and 26 May).

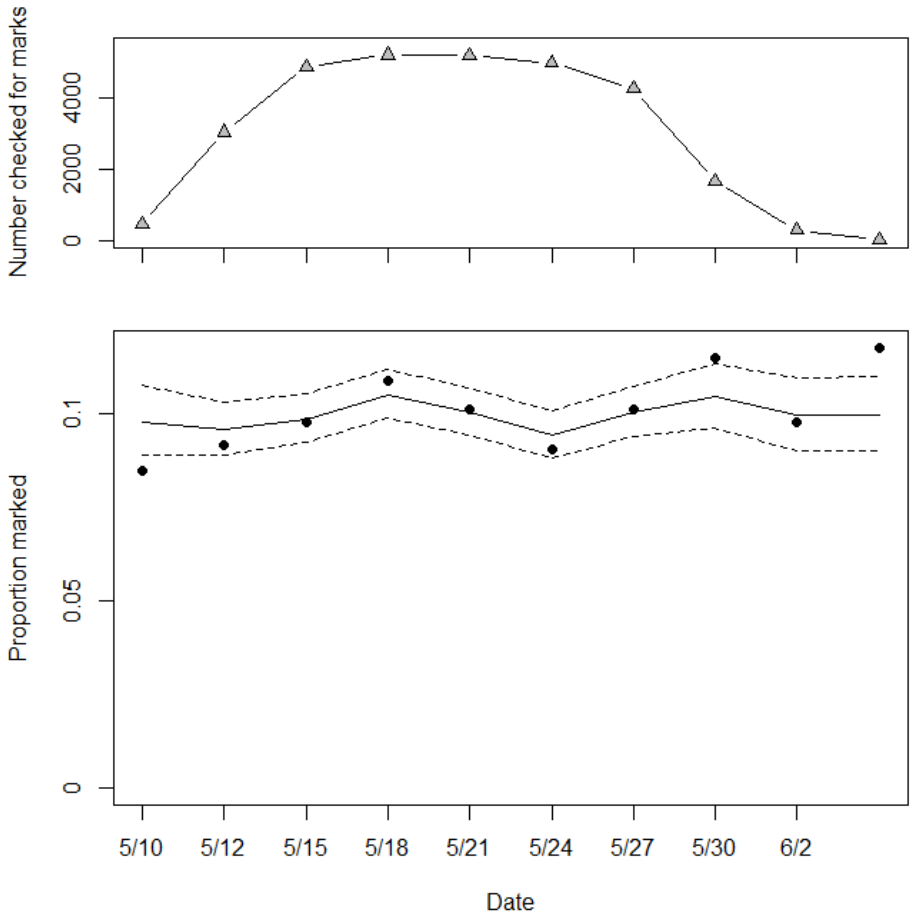


Figure 2. Estimated proportion of the Delaware Bay stopover population that has leg flags in 2016. Marked proportion was estimated from marked-ratio scan samples for each 3-day sampling period. The dates for the sampling periods are shown in Appendix 3. Sample size (number scanned, i.e., checked for marks) for each sample period is shown in the upper panel. The estimated proportion marked at each sample occasion (bottom panel) was estimated with the generalized linear mixed model described in Appendix 4. Solid and dashed lines are median proportion marked and 95% CI; filled circles show number with marks/number scanned.

Appendix 1. Number of flagged Red Knots detected each year since 2005.

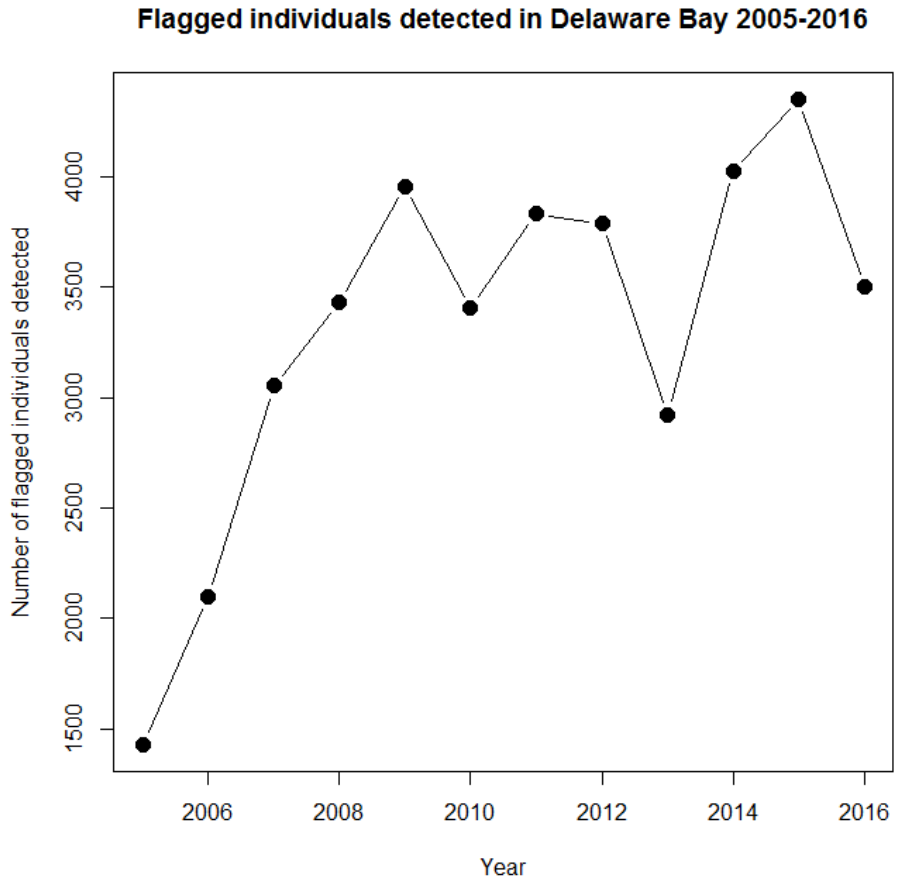


Figure A1. Number of flagged birds detected in Delaware Bay by Delaware and New Jersey crews since 2005. The number of flags detected in 2016 (n = 3510) is the second-lowest since 2010 (n = 3404).

Appendix 2. Number of marked-ratio scan samples.

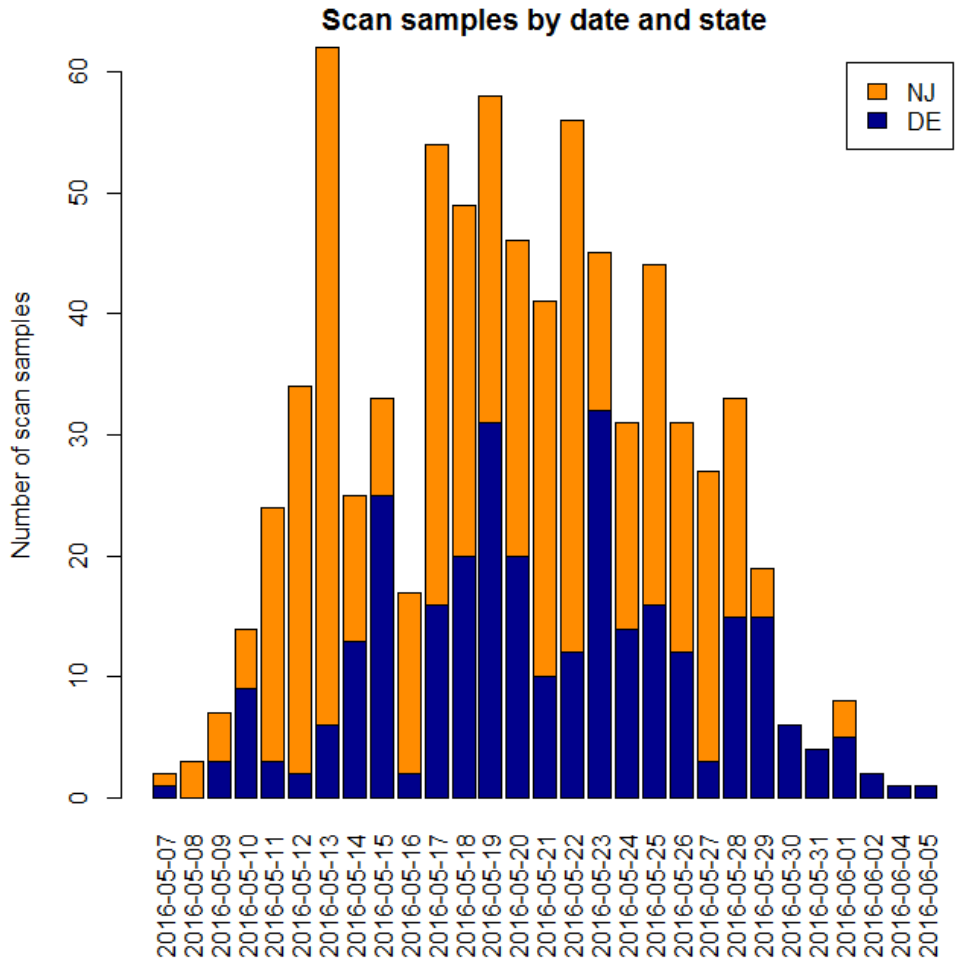


Figure A2. Number of marked-ratio scan samples collected in Delaware Bay in 2016 by field crews in Delaware (blue) and New Jersey (orange).

Appendix 3. Summary of 2016 mark-resight data ("m-array"). NR = never resighted.

			Next resighted at sample									
Sample	Dates	Resighted	2	3	4	5	6	7	8	9	10	NR
1	7-10 May	200	108	37	8	3	8	6	3	0	0	27
2	11-13 May	667		401	62	28	15	23	2	0	0	136
3	14-16 May	1153			409	168	108	78	7	3	0	380
4	17-19 May	1123				415	143	98	15	3	0	449
5	20-22 May	1180					350	162	33	3	0	632
6	23-25 May	1019						283	44	3	0	689
7	26-28 May	946							116	9	0	821
8	29-31 May	315								14	0	301
9	1-3 June	72									1	71

Appendix 4. Statistical Methods to Estimate Stopover Population Size Using Mark-Resight Data and Counts of Marked Birds

We converted the observations of marked birds into encounter histories, one for each bird, and analyzed the encounter histories with a Jolly-Seber (JS) model (Jolly 1965, Seber 1965, Crosbie and Manly 1985, Schwarz and Arnason 1996). The JS model includes parameters for recruitment (β), survival (φ), and capture (p) probabilities; in the context of a mark-resight study at a migration stopover site, these parameters are interpreted as probability of arrival to the study area, stopover persistence, and resighting, respectively. Stopover persistence is defined as the probability that a bird present at time t remains at the study area until time $t + 1$. The Crosbie and Manley (1985) and Schwarz and Arnason (1996) formulation of the JS model also includes a parameter for superpopulation size, which in our approach to mark-resight inferences for stopover populations is an estimate of the marked (leg-flagged) population size.

We chose to use 3-day periods rather than days as the sampling interval for the JS model given logistical constraints on complete sampling of the study area; multiple observations of the same individual in a given 3-day period were combined for analysis. A summary (m-array) of the mark-resight data is presented in an appendix.

We made inference from a fully-time dependent model; arrival, persistence, and resight probabilities were allowed to vary with sampling period [β_t φ_t p_t]. In this model, we set $p_1 = p_2$ and $p_{K-1} = p_K$ (where K is the number of samples) because not all parameters are estimable in the fully-time dependent model (Jolly 1965, Seber 1965, Crosbie and Manly 1985, Schwarz and Arnason 1996).

We followed the methods of Royle and Dorazio (2008) and Kéry and Schaub (2012, Chapter 10) to fit the JS model using the restricted occupancy formulation. Royle and Dorazio (2008) use a state-space formulation of the JS model with parameter-expanded data augmentation. For parameter-expanded data augmentation, we augmented the observed encounter histories with all-zero encounter histories (n = 2000) representing potential recruits that were not detected (Royle and Dorazio 2012). We followed Lyons et al. (2016) to combine the JS model with a binomial model for the counts of marked and unmarked birds in an integrated Bayesian analysis. Briefly, the counts of marked birds (m_s) in the scan samples are modeled as a binomial random variable:

$$m_s \sim Bin(C_s, \pi), \quad (1)$$

where m_s is the number of marked birds in scan sample s, C_s is the number of birds checked for marks in scan sample s, and π is the proportion of the population that is marked. Total stopover population size $\widehat{N^*}$ is estimated by

$$\widehat{N^*} = \widehat{M^*}/\hat{\pi} \quad (2)$$

where $\widehat{M^*}$ is the estimate of marked birds from the J-S model and $\hat{\pi}$ is the proportion of the population that is marked (from Eq. 1). Estimates of marked subpopulation sizes at each resighting occasion t $\left(\widehat{M_t^*}\right)$ are available as derived parameters in the analysis. We calculated an estimate of population size at each mark-resight sampling occasion $\widehat{N_t^*}$ using $\widehat{M_t^*}$ and $\hat{\pi}$ as in equation 2.

To better account for the random nature of the arrival of marked birds and addition of new marks during the season, we used a time-specific model for proportion with marks in place of equation 1 above:

$$m_{s,t} \sim Binomial\left(C_{s,t}, \pi_t\right) \quad (3)$$

$$for\ s\ in\ 1, \ldots, n_{samples}\ and\ t\ in\ 1, \ldots, n_{occasions}$$
$$logit(\pi_t) = \alpha + \delta_t$$
$$\delta_t \sim Normal(0, \sigma^2_{occasions})$$

where m_s is the number of marked birds in scan sample s, C_s is the number of birds checked for marks in scan sample s, δ_t is a random effect time of sample s, and π_t is the time-specific proportion of the population that is marked. Total stopover population size $\widehat{N^*}$ was estimated by summing time-specific arrivals of marked birds to the stopover (B_t) and expanding to include unmarked birds using estimates of proportion marked:

$$\widehat{N^*} = \sum \widehat{B_t} / \pi_t$$

Time-specific arrivals of marked birds are estimated from the Jolly-Seber model using $\widehat{B_t} = \widehat{\beta_t}\widehat{M^*}$ where $\widehat{M^*}$ is the estimate of the number of marked birds and $\widehat{\beta_t}$ is the fraction of the population arriving at time t.

Appendix 5 Minimum length-of-stay

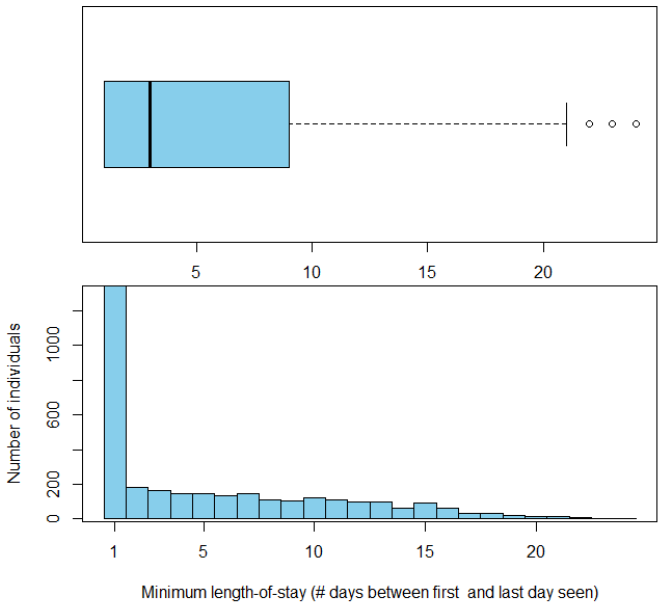


Figure A5. Minimum length-of-stay (MINLOS) in 2016 (n = 3,510 birds). This is a plot of raw data and is not a model-based estimate. MINLOS does not account for time present before first, or after last, detection and therefore is negatively biased. The mean and median MINLOS in 2016 were 5.3 days and 3 days, respectively. Model-based estimates of stopover duration suggest that stopover in 2016 was approximately 12 days.

Associates of Cape Cod, Inc.
124 Bernard E St. Jean Drive
East Falmouth Massachusetts 02536

05 OCT 2016

Atlantic States Marine Fisheries Commission
1050 N. Highland St.
Ste. 200
Arlington, Virginia 22201

RE: Response to proposed changes to ARM, Addendum VIII

Dear Commissioners,

Associates of Cape Cod, Inc. (ACC) has participated in a catch and release fishery of horseshoe crabs (HSC) in the New England region for well over 40 years. Although ACC does not participate in the Delaware Bay biomedical collection, we do have a strong contingent interest in management of this proximal east coast fishery. We share the desire for a healthy and sustainable population of HSC's, however, we cannot support proposals in proposed Addendum VIII that includes 1. The possibility of a limit on the availability of HSCs particularly when biomedical collection is not detrimental to the maintenance of a strong HSC fishery; and 2. The requirement to remove the protection of confidentiality of company data that helps insures a level playing field.

These animals are the key resource required to produce endotoxin reagents, which are a critical element in protecting the public from contaminated pharmaceuticals and medical devices as well as clinical diagnostic products that help physicians manage patients suffering from invasive fungal infections. An unexpected increase in demand for the reagents should not be delayed or constrained due to the limited availability of HSC's. The proposed addendum contains potential unintended negative consequences. Similarly, we cannot support any proposals that could compromise the confidentiality of the biomedical industries private information without significant benefit to the conservation of the HSC fishery.

Conservation efforts surrounding the bait industry have reduced overall harvest of the animal but mortality remains at 100% and is orders of magnitude greater than the biomedical mortality. The biomedical industry has a greater than 40 year history of being a catch and release fishery. Current research indicates that the impact of a biomedical fishery is minimal to the animals, and data from the ASMFC clearly demonstrates that the biomedical catch and release fishery has a very small impact on overall mortality. ACC cannot see the advantage to the HSC fishery that placing limits on the biomedical catch and release would provide. We appreciate the interest in supporting the fishery, but limiting catch and release harvest - which leaves such a very small mark on the fishery – introduces new risk to those who utilize this resource with no offsetting advantage to effectively protect the fishery.

I do appreciate your attention to this most important matter and ask that this material be made available for the annual meeting in October.

Best regards,

Brett Hoffmeister
Asst. Production Manager

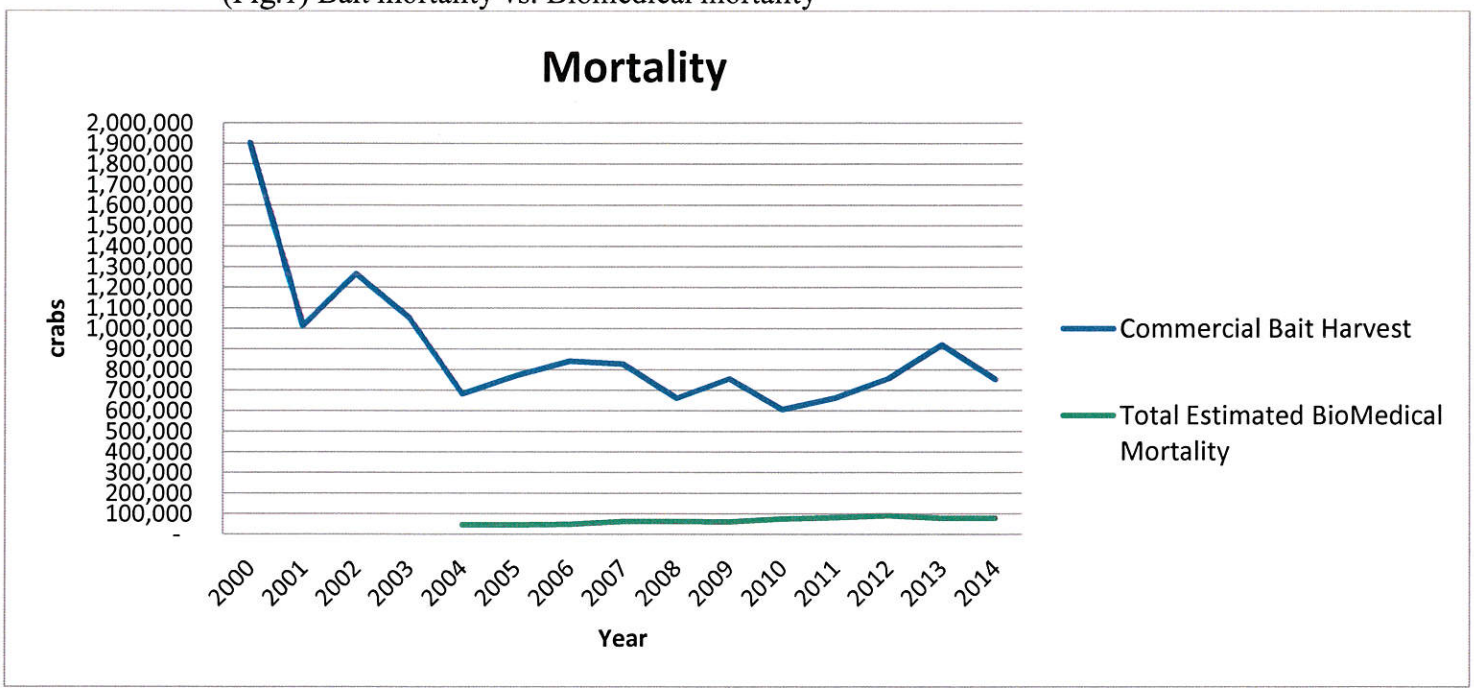
Enclosure:

Associates of Cape Cod, Inc. does not support the following recommendations of the ARM subcommittee for the following reasons:

Item1. *Incorporate biomedical mortality into the Adaptive Resource Management (ARM) process and methods that are used to set harvest quotas in the Delaware Bay Region.*

1. The reason to implement a change is misleading. Originally, a 57,500 threshold was set to trigger a review of the biomedical fishery, but it is unclear how this number was derived. This threshold was never intended to indicate the species was in a decline, but rather trigger an evaluation of the fishery if biomedical estimated mortality exceeded this threshold. While the biomedical mortality estimate may have increased over time, when compared to the amount of crabs harvested for bait, it is almost insignificant. The number of crabs adversely affected by the biomedical harvest process is not impactful to the population when compared to the mortality of crabs harvested for bait.

(Fig.1) Bait mortality vs. Biomedical mortality



Mortality data source ASMFC FMPs (see reference)

A periodic review of the biomedical mortality is supported, but the data does not support that a change in strategy is needed at this time. The bait industry is the leading cause of mortality and should be regulated accordingly as is currently done. To require the biomedical mortality data to be included in the ARM when it is such a small percentage of the number of crabs harvested will not add real value to the ARM. While this may seem inconsequential at first glance, the risks do not outweigh the benefit. The risks involved in including the biomedical data in the ARM process is as follows:

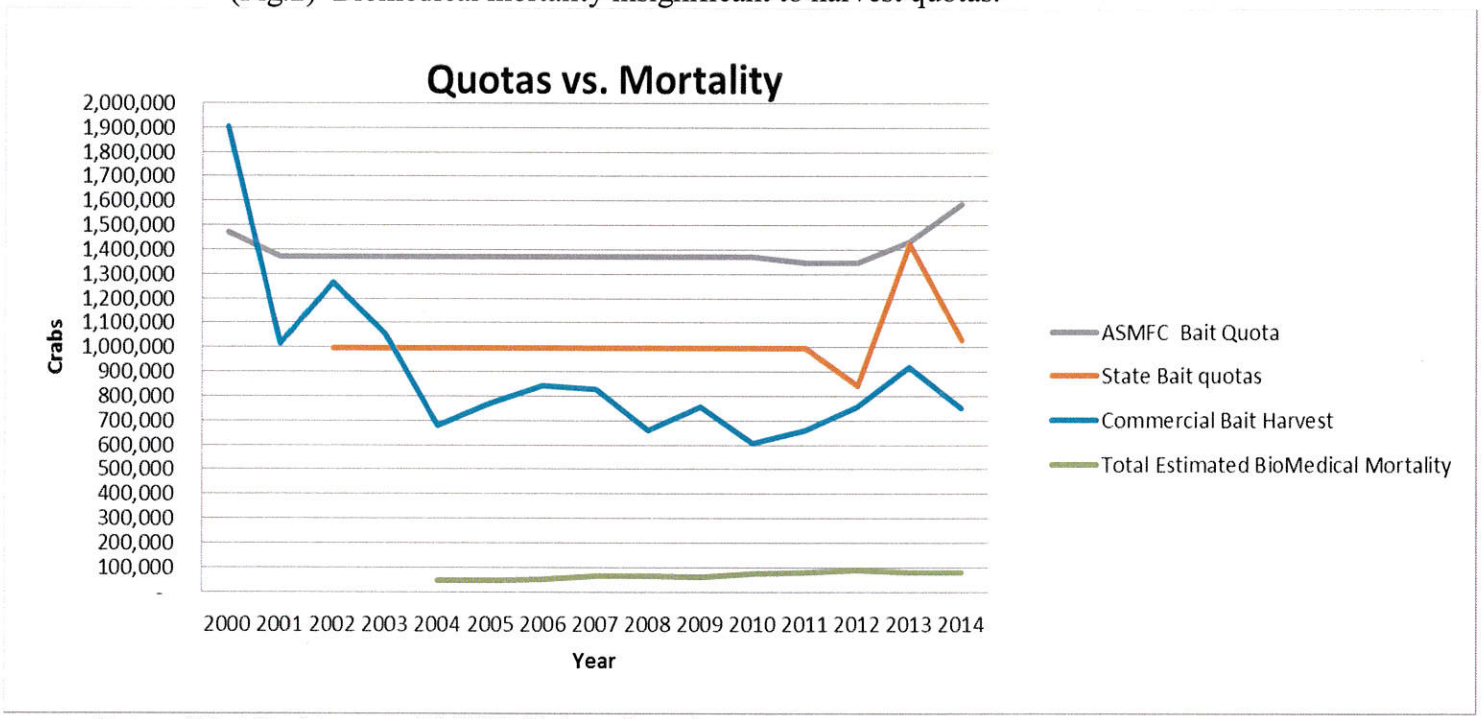
A. The variable data could require quotas for the biomedical industry based on output from unreliable estimates of red knot populations. If biomedical harvest were to be limited, this poses a direct impact to human health. The horseshoe crab blood is used specifically to make LAL, which is a product used to detect life threatening bacteria in any vaccine, medicine, or medical device that enters a human body. There is no alternative that is as reliable or accurate, and to prevent this product from being manufactured could directly affect the availability of vaccines, drugs, diagnostics or medical devices. There are times when an unanticipated increase in LAL production is needed, such as during pandemics and outbreaks like those in our recent past.

Examples are bird flu, swine flu and measles. To establish quotas on the biomedical harvest when the mortality estimates are so minimal is irresponsible.

B. The release of biomedical data in the Delaware Bay region as an aggregate may not in theory compromise the confidentiality of those biomedical facilities, but in reality it would do just that. The companies in that region are not created equal and the data, even as an aggregate, would give telling data from the main source company in the Delaware Bay region. This would by default, make the data available to the other companies as each company could mathematically determine the competitor's information based on what came out of the Delaware Bay region and vice versa.

2. A review of harvest data over the past 14 years indicates that conservation efforts have reduced overall harvest rates and that overall harvest and related mortality is well below the thresholds set by the ASMFC and individual states that often opt for a more conservative approach to quota management.

(Fig.2) Biomedical mortality insignificant to harvest quotas.



Quota and Mortality data source ASMFC FMPs (see reference)

Item 2; *Require each company to submit confidential data on its own levels of mortality at each stage (capture, transport, holding, bleeding, and condition at release)*

We would like to take this opportunity to remind the members of the ASMFC that the process of creating LAL is a highly regulated activity that already includes monthly reporting to state authorities the numbers, sex, mortality, and origin of horseshoe crabs we utilize by both the biomedical company and the supplier(s). This information is summarized by the state authorities and reported to the ASMFC annually. This proposal is redundant, provides no apparent benefit and burdens the companies and fisherman with unrealistic expectations such as assessing and recording the sex and state of health of each crab at release. The biomedical companies and biomedical fisherman have been supplying reliable and accurate information to the regulating authorities for many years.

Item 3: *Require each company to submit an annual report regarding its specific measures, practices, and safeguards to implement the 2011 Biomedical handling BMPs, and documentation that crabs are being returned to the same waters from which they were collected.*

The majority of BMPs formalized in 2011, including live release, had been in practice for decades. Our operations are widely scrutinized by local, state and federal authorities, as well as US and international regulators, customers, and internal quality control. We take our current reporting responsibilities very seriously and have performed to expectations. Additional reporting and documentation adds no value, and presents an undue burden on an industry that is already highly regulated, documented and audited.

Conclusion:

Associates of Cape Cod, Inc. commends the efforts of the horseshoe crab ARM subcommittee and the fine work done in an effort to stabilize populations of both the horseshoe crab (HSC) and red knot in the Delaware Bay region. The relationship between the biomedical facilities and fisheries managers is longstanding and productive. Over 40 years of conservation efforts have proven to be effective. The proposed changes (Addendum VIII) to the ARM are based on a requirement that a review take place after achieving a biomedical mortality threshold (57,500 crabs) of unknown impact. Given the data, it would be reasonable to conclude that the biomedical fisheries are of little, if any, impact. Therefore, a change to the ARM that includes increased supply risk and possible negative impact to an industry that provides such a vital and important product is unwarranted.

References:

Atlantic States Marine Fisheries Commission. (n.d.). Retrieved September 30, 2016, from http://www.asmfc.org/species/horseshoe-crab

Marine Fisheries
ENVIRONMENTAL QUALITY

PAT McCRORY
Governor

DONALD R. VAN DER VAART
Secretary

BRAXTON C. DAVIS
Director

Sept. 12, 2016

Kirby Rootes-Murdy, FMP Coordinator
Atlantic States Marine Fisheries Commission
1050 N. Highland Street
Suite 200 A-N
Arlington, VA 22201

Dear Mr. Rootes-Murdy,

This past summer North Carolina reached its Atlantic States Marine Fisheries Commission (ASMFC) directed quota of 24,036 individual horseshoe crabs. While we were aware that the horseshoe crab quota could be reached within a calendar year we were not concerned because there are no directed fisheries and the daily harvest limit was set at only 50 horseshoe crabs per vessel per trip. Rule changes in 2011 have broadened the N.C. Division of Marine Fisheries (NCDMF) Fisheries Director's proclamation authority to include seasons, areas, quantity, means and methods, and size limits that can be implemented within 48 hours. This provides more flexibility to stay in compliance with the ASMFC Interstate Fishery Management Plan (FMP) for Horseshoe Crabs. Through proclamation, the open harvest season was reduced by one month for 2016 to reduce harvest and help prevent a quota overage from occurring.

The North Carolina Trip Ticket Program captures all seafood harvested and sold within North Carolina but there is a two-month time lag for the verification process to capture this information. Harvest of horseshoe crabs was allowed during a seasonal open harvest window from January 1 through April 30, 2016 to provide time for the verification process to offer a more accurate estimate of landings. It was identified in August that there was a quota overage for 2016, estimated at 999 horseshoe crabs. All landings estimates in 2016 are preliminary at this time.

Addendum II of the ASMFC FMP indicates that voluntary quota transfers are allowed between states so long as the transfer is biologically sound. To be biologically responsible, the quota transfer should occur within a population and must be predicated on stock delineation and estimates of stock size. Population data from North Carolina is limited and the closest state for a transfer would be Georgia. Georgia has recorded no commercial horseshoe crab landings since 1999. The required transfer is low and commercial harvest in both states is either minimal or non-existent in recent years compared to the overall coast-wide harvest allowance.

The NCDMF contacted the Georgia Department of Natural Resources to determine if they would be willing to assist us in addressing our overage through a quota transfer. The Georgia Department of Natural Resources has agreed to transfer 1,250 horseshoe crabs from Georgia to North Carolina, increasing North Carolina's 2016 quota to 25,236 individuals. This transfer will cover the 2016 overage in North Carolina. Four previous quota transfers occurred between Georgia and North Carolina in 2009, 2011, 2013 and 2015.

Horseshoe crab landings in North Carolina have remained below the harvest quota, ten of seventeen years since its inception in 2000 (Figure 1). A quota overage of 331 individuals occurred in 2003; 2,155 individuals in 2008; 8,989 individuals in 2009; 3,091 individuals in 2011; 803 individuals in 2015; and 999 individuals in 2016 (Figure 1). The overages in 2003 and 2008 occurred in December due to large landings in the blue crab trawl fishery, and a daily harvest limit of 500 horseshoe crabs per vessel per trip. The quota overages in 2009 and 2011 occurred in May and June respectively, and the majority of the landings (63% and 52%) again came from the blue crab trawl fishery when the trip harvest limit could be set no lower than 500 horseshoe crabs per vessel per day by rule. The 2013 quota overage occurred in the month of July, while 85% of the landings occurred in May and June, mostly from gill nets. The overage in 2015 occurred in May, and was due to strong catches from gillnets, crab trawls, and pound nets. In 2016, landings stayed within the quota during the open harvest season. Unfortunately, late harvest in May, primarily from gill nets, caused the 2016 overage.

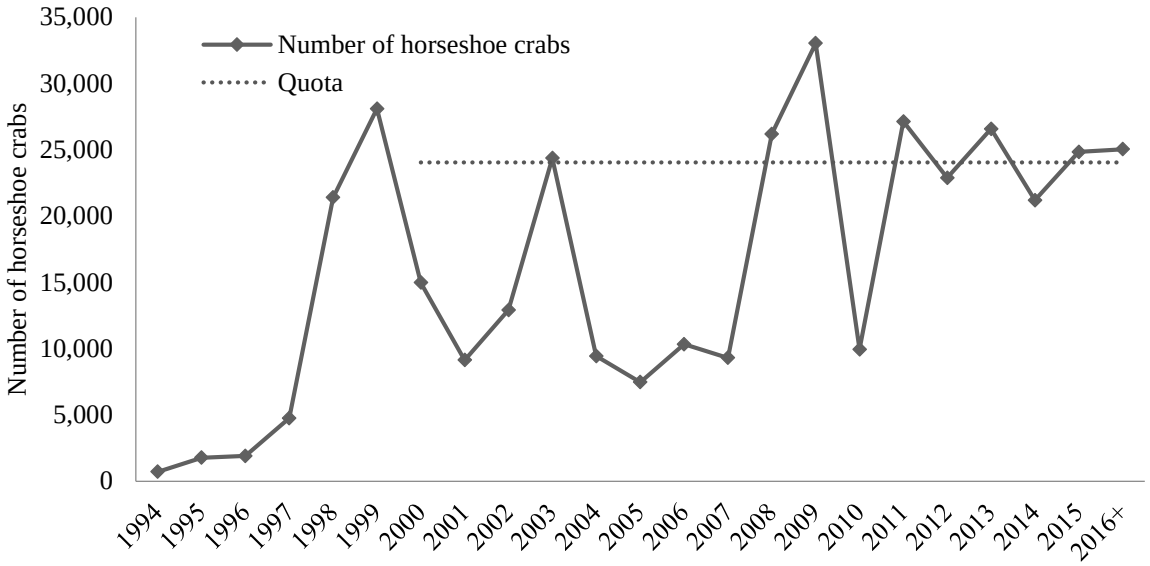


Figure 1. North Carolina horseshoe crab landings (number, 1994 – 2016), including the harvest quota in 2000. +Landings for 2016 are preliminary at this time and subject to change.

Horseshoe crab landings will continue to be monitored through the trip ticket program, and if landings reach the quota, North Carolina will continue to adjust management measures via proclamation authority. For 2017, we plan to continue a January 1 through April 30 open harvest period at a trip limit of 50 horseshoe crabs. Should verification of landings determine that a short re-opening could occur, North Carolina may consider that option. It is important to note that the current management measures were effective in constraining harvest to the quota, but illegal post-closure harvest resulted in an overage.

Further concerns include impacts of the quota transfer on shorebird populations and biomedical industry. No biomedical permits have been issued in North Carolina in over a decade. Whether Georgia or North Carolina is considered a critical stopover for migratory shorebirds, including red knots, is undetermined. Restrictions on harvest of horseshoe crabs from the Delaware Bay region, the epicenter of horseshoe crab production on along the east coast, has been the prime area of focus in regards to the impacts on egg availability to shorebirds migration.

State of North Carolina | Environmental Quality | Marine Fisheries
PO Box 769 | 3441 Arendell Street | Morehead City, NC 28557
252 726 7021 T

If you need additional information concerning this request, please contact me via e-mail at Braxton.Davis@ncdenr.gov or by phone at 252-808-8013. Thank you for your assistance on this matter.

Sincerely,

Braxton C. Davis, Director
Division of Marine Fisheries

cc: Spud Woodward
Stephanie McInerny
Grace Kemp
Jeff Dobbs

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
COASTAL RESOURCES DIVISION

MARK WILLIAMS
COMMISSIONER

A.G. 'SPUD' WOODWARD
DIRECTOR

September 7, 2016

Braxton C. Davis, Director
North Carolina Division of Marine Fisheries
P.O. Box 769
3441 Arendell Street
Morehead City, North Carolina 28557

Dear Mr. Davis,

I received your correspondence dated August 29, 2016 in which you requested that the State of Georgia transfer 1,250 horseshoe crabs from its available quota for calendar year 2016 to the State of North Carolina as allowed in the ASMFC Interstate Fishery Management Plan for Horseshoe Crab.

There has been no reported harvest of horseshoe crabs in Georgia thus far during 2016, and we do not anticipate there being any reported harvest. Thus, we have adequate unused quota to transfer per your request. Therefore, it is my pleasure to respond in the affirmative. Please have ASMFC staff contact me, if they have any questions.

Sincerely,

A.G. "Spud" Woodward
Director

cc: Patrick Geer
Michelle Duval

ONE CONSERVATION WAY | BRUNSWICK, GEORGIA 31520-8686
912.264.7218 | FAX 912.262.3143 | WWW.COASTALGADNR.ORG

Marine Fisheries
ENVIRONMENTAL QUALITY

PAT McCRORY
Governor

DONALD R. VAN DER VAART
Secretary

BRAXTON C. DAVIS
Director

Aug. 29, 2016

Spud Woodward, Director
Coastal Resources Division
Georgia Department of Natural Resources
One Conservation Way
Brunswick, GA 31520

Dear Mr. Woodward,

This past summer North Carolina reached its Atlantic States Marine Fisheries Commission (ASMFC) directed quota of 24,036 individual horseshoe crabs. While we were aware that the horseshoe crab quota could be reached within a calendar year we were not concerned because there are no directed fisheries and the daily harvest limit was set at only 50 horseshoe crabs per vessel per trip. Rule changes in 2011 have broadened the N.C. Division of Marine Fisheries (NCDMF) Fisheries Director's proclamation authority to provide more flexibility to stay in compliance with the ASMFC Interstate Fishery Management Plan (FMP) for Horseshoe Crabs. Through a proclamation, the open harvest season was reduced by one month to January 1 through April 30 in 2016 to reduce harvest and help prevent another quota overage.

The North Carolina Trip Ticket Program captures all seafood harvested and sold within North Carolina, but there is a two-month time lag for the verification process to capture this information. Harvest of horseshoe crabs was allowed during a seasonal open harvest window from January 1 through April, 2016 to provide time for the verification process to offer a more accurate estimate of landings. It was identified in August that there was a quota overage for 2016 estimated at 999 horseshoe crabs. All landings estimates in 2016 are preliminary at this time.

Addendum II of the ASMFC FMP indicates that voluntary quota transfers are allowed between states so long as the transfer is biologically sound. To be biologically responsible, the quota transfer should occur within a population and must be predicated on stock delineation and estimates of stock size. Horseshoe crabs found in North Carolina are considered a small subpopulation in the southeast. A quota transfer occurred for the 2009, 2011, 2013, and 2015 seasons between North Carolina and Georgia because the technical Committee's recommendation of the closest state at those times was Georgia.

We would like to request the Georgia Department of Natural Resources assistance in addressing our horseshoe crab overage through a quota transfer as authorized by the ASMFC FMP. We request a transfer of 1,250 horseshoe crabs for calendar year 2016. If the Georgia

Department of Natural Resources agrees with the proposed transfer, we will request the ASMFC to adjust our respective quotas to reflect the changes.

I look forward to hearing from you on our proposal for quota transfer.

Sincerely,

Braxton C. Davis, Director
Division of Marine Fisheries

cc. Stephanie McInerny, Grace Kemp, Jeff Dobbs, Michelle Duval