Atlantic States Marine Fisheries Commission

Shad and River Herring Management Board

October 17, 2017
8:00 – 9:30 a.m.
Norfolk, Virginia

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. Clark)* 8:00 a.m.

2. Board Consent 8:00 a.m.
   - Approval of Agenda
   - Approval of Proceedings from August 2017

3. Public Comment 8:05 a.m.

4. Discuss Shad Stock Assessment Process Recommendations (*J. Kipp*) 8:15 a.m.

5. Consider Approval of Shad and River Herring Sustainable Fishery Management Plans (SFMPs) **Final Action** 8:25 a.m.
   - Review SFMPs and Technical Committee Memo *(B. Chase)*
     - Connecticut – Updated Shad SFMP
     - Potomac River Fisheries Commission – Updated Shad SFMP
     - North Carolina – Updated Shad SFMP
     - South Carolina – Updated Shad SFMP
     - Georgia – Updated Shad SFMP
     - Virginia – Bycatch Plan

6. Consider Approval of 2017 FMP Review and State Compliance Reports (*C. Starks*) **Action** 9:15 a.m.

7. Other Business/Adjourn 9:30 a.m.

The meeting will be held at the Waterside Marriot Hotel, 235 East Main Street, Norfolk, Virginia; 757.627.4200

MEETING OVERVIEW

Shad and River Herring Management Board Meeting
Tuesday October 17, 2017
8:00 – 9:30 a.m.
Norfolk, Virginia

Chair: John Clark (DE) Assumed Chairmanship: 2/17	Technical Committee Chair: Brad Chase (MA)	Law Enforcement Committee Representative: L. Furlong (PA)
Vice Chair: Mike Armstrong	Advisory Panel Chair: Pam Lyons Gromen	Previous Board Meeting: August 2, 2017
Voting Members: ME, NH, MA, RI, CT, NY, NJ, PA, DE, MD, DC, PRFC, VA, NC, SC, GA, FL, NMFS, USFWS (19 votes)		

2. Board Consent

- Approval of Agenda
- Approval of Proceedings from August 2017

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. Discuss Shad Stock Assessment Process Recommendations

Background

- The 2007 Benchmark Stock Assessment was scheduled to be updated in 2018. The Assessment Science Committtee recommended performing a benchmark assessment due to differences in data and methods from the 2007 Benchmark Stock Assessment.

Presentations

- Shad Stock Assessment Process Recommendations by J. Kipp

5. Consider Approval of Sustainable Fishery Management Plans (Final Action)

Background

- The Connecticut Department of Energy and Environmental Protection submitted an updated SFMP for recreational and commercial harvest of American shad in the Connecticut River. The plan includes recent data and requests to maintain the existing management measures from the 2012 SFMP. Commercial shad fishing will remain prohibited in all other rivers in the state. (**Briefing Materials**)
- The Potomac River Fisheries Commission submitted an updated SFMP for a continued limited commercial bycatch allowance of American shad. The plan includes recent data

and requests to maintain the existing management measures from the 2012 SFMP. (**Briefing Materials**)

- The North Carolina Division of Marine Fisheries submitted an updated SFMP for commercial and recreational harvest of American shad. The plan includes updated sustainable management measures from the 2012 SFMP and requests to maintain fisheries in all coastal rivers. (**Briefing Materials**)
- The South Carolina Department of Natural Resources submitted an updated SFMP for commercial and recreational harvest of American shad. The plan includes recent data and requests to maintain the fisheries at current or reduced levels from the 2011 SFMP. (**Briefing Materials**)
- The Georgia Department of Natural Resources submitted an updated SFMP for commercial and recreational harvest of American shad, with the revisions requested by the Board at the May 2017 meeting. (**Briefing Materials**)
- The Technical Committee reviewed the documents and provided recommendations to the Board. (**Supplemental Materials**)

Presentations

- Overview of the SFMPs and Technical Committee Recommendations by B. Chase

Board actions for consideration at this meeting

- Approval of the Sustainable Fishery Management Plans

6. Consider Approval of 2017 Shad and River Herring FMP Review

Background

- State Compliance Reports were due on July 1, 2014
- The Plan Review Team reviewed each state report and compiled the annual FMP Review **(Briefing Materials)**

Presentations

- Overview of the FMP Review Report by C. Starks

Board actions for consideration at this meeting

- Approve 2017 FMP Review and *de minimis* requests

7. Other Business/Adjourn

DRAFT PROCEEDINGS OF THE

ATLANTIC STATES MARINE FISHERIES COMMISSION

SHAD AND RIVER HERRING MANAGEMENT BOARD

The Westin Alexandria
Alexandria, Virginia
August 2, 2017

These minutes are draft and subject to approval by the Shad and River Herring Management Board. The Board will review the minutes during its next meeting.

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ATTENDANCE

Board Members

Pat Keliher, ME (AA)
Cheri Patterson, NH, proxy for D. Grout (AA)
Dennis Abbott, NH, proxy for Sen. Watters (LA)
Ritchie White, NH (GA)
Mike Armstrong, MA, proxy for D. Pierce (AA)
Raymond Kane, MA (GA)
Sarah Ferrara, MA, proxy for Rep. Peake (LA)
Mark Gibson, RI, proxy for J. Coit (AA)
David Borden, RI (GA)
Eric Reid, RI, proxy for Sen. Sosnowski (LA)
Justin Davis, CT, proxy for M. Alexander (AA)
Sen. Craig Miner, Ct (LA)
John McMurray, NY, proxy for Sen. Boyle (LA)
Jim Gilmore, NY (AA)
Emerson Hasbrouck, NY (GA)
Heather Corbett, NJ, proxy for L. Herrighty (AA)
Tom Fote, NJ (GA)
Adam Nowalsky, NJ, proxy for Asm. Andrzejczak (LA)
Andy Shiels, PA, proxy for J. Arway (AA)
Loren Lustig, PA (GA)
John Clark, DE, proxy for D. Saveikis (AA)
Craig Pugh, DE, proxy for Rep. Carson (LA)
Roy Miller, DE (GA)
Lynn Fegley, MD, proxy for D. Blazer (AA)
Rachel Dean, MD (GA)
Allison Colden, MD, proxy for Del. Stein (LA)
Kyle Schick, VA, proxy for Sen. Stuart (LA)
Cathy Davenport, VA (GA)
Rob O'Reilly, VA, proxy for J. Bull (AA)
Michelle Duval, NC, proxy for B. Davis (AA)
David Bush, NC, proxy for Rep. Steinburg (LA)
Sen. Ronnie Cromer, SC (LA)
Malcolm Rhodes, SC (GA)
Ross Self, SC, proxy for R. Boyles (AA)
Pat Geer, GA, proxy for Rep. Nimmer (LA)
Rep. Thad Altman, FL (LA)
Spud Woodward, GA (AA)
Jim Estes, FL, proxy for J. McCawley (AA)
Martin Gary, PRFC
Sherry White, USFWS
Derek Orner, NMFS

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

Ex-Officio Members

Brad Chase, Technical Committee Chair

Staff

Bob Beal
Toni Kerns
Kirby Rootes-Murdy
Jeff Kipp
Katie Drew

Guests

Arnold Leo, E. Hampton, NY

The Shad and River Herring Management Board of the Atlantic States Marine Fisheries Commission convened in the Edison Ballroom of the Westin Hotel, Alexandria, Virginia, August 2, 2017, and was called to order at 8:00 o'clock a.m. by Chairman John Clark.

CALL TO ORDER

CHAIRMAN JOHN CLARK: This is the first part of our diadromous double header here. We're going to start with Shad and River Herring; and welcome to the meeting. I'll just give everybody a second to settle in here.

APPROVAL OF AGENDA

CHAIRMAN CLARK: Do we have any changes to the agenda? Seeing none; the agenda is approved.

APPROVAL OF PROCEEDINGS

CHAIRMAN CLARK: Do we have any changes or questions about the minutes from the previous meeting? Seeing none; the minutes are approved.

PUBLIC COMMENT

CHAIRMAN CLARK: We're on to Item 3, which is Public Comment, and we have been asked by Jeff Pierce to give a comment here; so Jeff, do you want to go up to the public microphone?

MR. JEFFREY PIERCE: Good morning, Chairman Clark, distinguished members of the Shad and River Herring Board. My name is Jeff Pierce. I'm the founder and Executive Director of the Alewife Harvesters of Maine. My comments today are just a few for consideration for both this Board and the Technical Committee. Maine over the last decade has opened up thousands of acres of rivers and stream habitat through the removal of several large dams.

There are many river restoration projects going on in different communities to restore fish passage. Citizen scientists, conservation committees, local select boards and universities are working with like associations, Maine's Department of Marine Resources and other stakeholders to get many alewife and blueback herring collectively known as river herring, back into their native spawning ground.

Maine Department of Transportation has also been working diligently on stream passage, with a culvert replacement program; which recently gained approval for additional funding from the Maine State Legislature. These are just a few examples of the positive conservation restoration efforts going on in Maine and Massachusetts.

There are similar restoration efforts going on with citizen scientists and the other local community efforts. Many of us hope that the Technical Committee will take into consideration the social and economic effects of the community effort on river herring restoration; when they bring proposals to harvest river herring, and consider all the benefits and the aspects of this culturally important fishery, including basing their decisions on hard scientific data.

Allowing small scale commercial and education harvest builds good will when it comes time for municipal leaders to allocate funding for critical restoration work in their communities. Thank you for this opportunity to make public comment; and I would be happy to answer any questions you may have at this time.

CHAIRMAN CLARK: Thank you, Jeff. I'm sure Commissioners can talk to you after the meeting here; and get up with you on that. Thanks.

REVIEW OF RIVER HERRING STOCK ASSESSMENT UPDATE

CHAIRMAN CLARK: Okay, we're going to move on to Agenda Item 4; which is to Review the River Herring Stock Assessment Update, and for

that I'll turn it over to Technical Committee Chair, Brad Chase.

MR. BRAD CHASE: Good morning. I'm going to run through the river herring stock assessment update. I would like to start by thanking the Stock Assessment Subcommittee for all their good work to put this together. It was really a challenging endeavor; given all the different data sources they had to look at, and also a difficult time of the year.

I want to thank the staffers as well, for helping out; Jeff Kip, Kirby, and Ashton Harp for all the work they did to shepherd us through the SAS, as well as the TC review. I'll go through the background. It presents some of the data results, focusing on the abundance data, the biological metrics, and total mortality estimates; and then will finish up with a conclusion.

The SAS had recommended that trend analysis were updated after five years beyond the stock assessment in 2012, and that a newer benchmark assessment would be conducted in ten years from now in 2022. The feeling was that a full assessment really wasn't warranted at this point in time, because the variability in the indices from the previous assessment, and also there has been a number of changes that have occurred.

A number of states have put in harvest bans. There has been a fair amount of restoration activity to restore access to historic spawning grounds, and we've had a number of sustainable fishery management plans that have been enacted; so it was felt that it would be too soon to conduct the assessment after just five years with all this activity; and given the life history of river herring.

River herring management should really ideally be conducted on a river specific basis. This is difficult because there are so many individual systems, and also these stocks do mix in the marine environment; so you have a diadromous life history, which is complicated to produce a coastwide stock assessment.

You also have challenges in that you have different data quality among the river systems; and some systems have no data at all. Then again, you have limited information coming from the mixed stock ocean bycatch; where it is difficult to relate what happens at sea to back to the river specific stocks.

Instead of a coastwide model approach, it is more of a trend analysis. The most common trend analysis used is Mann-Kendall. The benchmark also produced reference points of total mortality; and this was repeated. There were several catch-at-age-population models conducted, one for Monument River in Massachusetts, and the Chowan River in North Carolina; and these were updated, but they did not factor heavily into the update.

They will be continued, and there was also a depletion-based stock reduction analysis that was conducted for the benchmark; but this was not endorsed by the Peer Review Panel, so it was not updated. So 57 river systems were evaluated on the east coast, of these 26 percent had complete or useable data. The SAS looked at nine categories of fishery independent and fishery dependent data by species; both blueback and alewife, harvest data, age, length, weight, repeat spawner ratios, and then adult juvenile and catch-per-unit effort fishery independent and dependent indices. A large majority of these did occur in New England states.

I'll run through like I guess the next slide, sorry about that. The benchmark was updated through 2015, so the update period was 2011 to 2015; and datasets that were reviewed for the benchmark that were found to be too brief, but had reached ten years by 2015, were included this time around. But in effect that was just the addition of one data series.

Overall the update lost data series as several datasets were discontinued, due to management actions, unreliability in the data sources, or lack of returning fish. To briefly mention commercial landings. Coastwide landings have been stable since the benchmark. The upper graph shows historical landings going back to about 1880.

I think we're all familiar with that large peak that occurred in the '50s, '60s, and '70s as domestic fleets went offshore fishing for sea herring and mackerel, and caught river herring as bycatch; and also foreign fleets came in as well, and led to really high landings in that period. Those landings declined sharply in the 1980s and you can see that red circle in the far right; that is where we are today.

Fairly stable landings since 2006, at about 1.4 million pounds, and the SAS felt that this information might have reduced utility, because we've had a number of harvest moratoria in place since then. Either way it does show stability in the benchmark period. Most of those commercial landings are occurring in Maine spawning run fisheries, or bycatch in offshore fisheries.

The incidental ocean bycatch has been stable, well I wouldn't say stable, but has been reduced since the benchmark. For the most recent period it's been 227 metric tons has been the average; which is about half of what it was in 2005 to 2010, where it was near 500 metric tons. Again, the impact of this catch on stock status is largely unknown; because we can't relate the mixing at sea very well back to river specific stocks.

I think it is good news to see that graph declining. A lot of folks have worked hard to try to gain more information on ocean bycatch; and we are seeing that reduction in recent years. Following a framework that was established during the benchmark, which was a consensus-base-expert-opinion framework to evaluate trends.

Trends were updated for abundance and total mortality. The terminal five-year trends that were determined during the benchmark were updated, and evaluated for the final ten years of the data series; which is 2006 to 2015. We'll go through those trends now. These trends are also summarized in Table 1 of the assessment update report.

I'll start with commercial catch-per-unit effort data. This shows the series that are presently active in dark lettering. The ones that have been discontinued are crossed out in red. For commercial CPUE there are just three series that are present. There were ten series before, and these have been discontinued for various reasons. What I'll do is show the trends; and you can see the arrow here. The SAS assigned trends of increasing, decreasing, stable, no trend due to high variability, or unknown. The symbols next to the trends, symbol RH means both alewife and blueback combined. A for alewife, B for blueback, and so these are the three commercial series, and you can see the Hudson River is increasing and the other two are stable. For run size data, quite a few states have counts on spawning run counts.

You can see that four series have been discontinued since the benchmark. You can also see there are very few south of New England. Here are the trends. It's a fairly mixed bag; but what you can see is there are none of these that are declining in this period of 2006 to 2015. For blueback, one is increasing, four have no trends. For alewife, six are increasing, eight have no trends.

Then combined series four increasing, two are stable. For this ten year period we have a general increasing trend with spawning run counts. Young of the year fishery independent survey data, nine states have these data surveys. Here are the trends. Again, it's mixed.

For blueback two are increasing, six have no trend.

For alewife, one is decreasing and six have no trend; and for combined species there is one with no trend. Fishery independent trawl survey data, there are five states that have these trawl surveys; then you have the New England Fisheries Science Center Bottom Trawl Survey that covers that large area in blue.

These are showing a fairly stable picture. A few of these are increasing. Three alewife are increasing, three with no trend for alewife. Blueback has one decreasing, one increasing, and four with no trend; fishery independent and fishery dependent length data, so we have quite a few series here. In this case mean length has either declined or is showing no significant trends for all rivers examined.

None of these mean length series are increasing. You have significant declines for alewife by sex in four of the nine river systems and the trawl survey, and significant declines for the blueback by sex in six of the nine systems examined. These results are fairly consistent with the benchmark period, and somewhat lower in some cases than historic data. A similar pattern is seen for max length data as well.

The fishery independent and fishery dependent age data, we have fewer data series. There are six states that have this information, with one series dropping out since the benchmark. If you combine these data there is 112 river specific age and species combinations; and 26 of these have reversed their significance from the benchmark analysis.

But the pattern is similar to mean length. In most cases mean length at age is declining; and each river has at least one age where there is decline in a mean length at age. Although there is this modest declining pattern; the coastwide pattern shows little change since the benchmark. Fishery independent and fishery dependent repeat spawner data, six states have these. Two of these have dropped out since the benchmark.

Repeat spawner data is very similar to mean length. These have all declined or showed no significant trend in all rivers examined. Significant declines have occurred for alewives by sex in four of the ten rivers examined for blueback; it is significant declines in two of the five rivers, and again the results are similar to the benchmark and it's a declining trend relative to historic data in some of these systems. These biological indicators that reflect on total mortality are showing a general decline; whereas the empirical estimates for total mortality have a little different story. These states either age otolith or scales for river herring. One of these series has dropped out since the benchmark. Here we have a fairly stable picture with three of these series declining in this period. Three have no trend, alewife has three decreasing, and seven have no trend.

Again, a slight decline in some of the series for the empirical total mortality estimates; whereas it is the opposite view for some of the biological indicators for total mortality. The SAS also produced Z benchmarks, and they used the spawning potential ratio; which looks at the total mortality rate that would reduce a spawning stock biomass to a specified percent of a virgin or unfished spawning stock biomass.

The SAS for the benchmark assessment picked a Z of 20 percent SPR, and a Z of 40 percent SPR to develop these reference points. The Peer Review looked at this and they recommended using the natural mortality rate of 0.7, and the preferred the Z at SPR 40 percent. This was repeated for the update. For the update Z continued to be high for most of the stocks.

They looked at the three-year-terminal average for observed Z values, and they looked at the 40

percent SPR value. For 12 of the 14 stocks that had available data, they were above that benchmark. During the benchmark assessment with the three-year average, there were 18 stocks that had available data; and all these were above the Z at 40 percent benchmark.

Recent Z values are not available for three stocks; due to lack of returning fish or aging errors. There are fewer series to look at. The picture improves slightly, but overall the mortality estimates were well above the reference point in most cases. To conclude, most data evaluated reflected conditions that were similar to the benchmark stock assessment.

Most of the fishery independent indices indicate inter-annual variation below stock size, and that more time is needed to reflect large scale changes in abundance. There were some positive trends; particularly in the spawning run counts in trends of abundance, particularly in the northeast. It's also interesting to point to trends in total mortality estimates and biological indicators of mortality were often in conflict.

Given the conflicting results for mortality estimates, conclusions about mortality remain uncertain. However, in comparison to reference points, some rivers have total mortality in recent years that may be unsustainable. Overall there were 16 of the 54 stocks that were reviewed for 2006 to 2015 that had increasing abundance trends.

Two were decreasing, 8 were stable, 10 experienced no discernible trend due to high variability, and 18 did not have enough data to assess recent trends. The coastwide status was determined to be depleted. There were positive signs that were apparent, but the information indicates the status of the river herring meta-complex population being depleted to near historic low remains unchanged since the benchmark stock assessment.

The depleted status indicates that there was evidence for declines in abundance due to numbers of factors such as predation, river mortality, fishing; but the relative importance of these factors in reducing river herring stocks could not be determined. I just wanted to mention that we have now in the river herring management there are five states that have approved sustainable fishery management plans. Maine has the largest number at 20. New Hampshire has several rivers in Great Bay. Massachusetts and New York have one each; and South Carolina has two, which we'll review shortly today. I would be happy to take any questions.

CHAIRMAN CLARK: Thank you, Brad. Do we have any questions for Brad about this presentation; first up, Emerson then Jim?

MR. EMERSON C. HASBROUCK: Thank you, Brad, for your presentation. I have two questions, Mr. Chairman. Can I ask them both? I have two questions, is that okay?

CHAIRMAN CLARK: Yes, sure.

MR. HASBROUCK: One is, and you went by it pretty quickly. It was towards the end of your presentation. Did you say that some rivers have total mortality? Did you say that some river systems have total mortality?

MR. CHASE: Yes, do you want to go back to that slide? There are several rivers that have estimates of total mortality.

MR. HASBROUCK: There have got to be some fish that return though, right?

MR. CHASE: No, the total mortality estimate is based on age structure of scales, otoliths that produce an estimate of the total mortality for that population, for that river specific

population. It's an estimate of the percent that would survive or die for that population.

MR. HASBROUCK: That's interesting. My other question is I noticed in the trawl surveys you didn't mention the NEMAP Survey. Do they not encounter any river herring?

MR. CHASE: I can't speak for if they do or they don't; but all data series that were available for the east coast were evaluated by the SAS, and they selected ones that were suitable for the update. I can't comment on that particular survey.

CHAIRMAN CLARK: Next up, Jim.

MR. JAMES J. GILMORE, JR.: Brad that was a great presentation. What happened in the Mid-Atlantic when we lost all those surveys is kind of interesting. I'm just wondering if there are other surveys, particularly like in New York we have I know at least three other surveys that are going on, on Long Island; the Peconics, we've gotten after Hurricane Sandy there was a breach.

Now the Clemons River is being monitored, and there have been fish ladders put into all that place, so there is like a whole new set of data; and I would be assuming up and down the coast. It doesn't look like that got incorporated; but is there may be a plan to get that in the future; because that seems to be a broader dataset that maybe we're not tapping at this point.

MR. CHASE: Yes, I think that is the intention of the SAS. There are many rivers on the east coast that are monitored presently; and the SAS looked at all the data available. The rule of thumb they're using is they want to see ten years of data. When a data series reaches that point, it will be considered. I think that as these data collection efforts mature, we'll see a number of series come to use; which will benefit the assessment.

CHAIRMAN CLARK: Next question is Roy Miller.

MR. ROY W. MILLER: Brad, you stated that the estimates of Z, total mortality, exceeded the benchmark in a number of cases. Do you have any feeling for how much of that Z is caused by offshore fisheries as opposed to inshore environmental factors and/or inshore harvest?

MR. CHASE: It's an excellent question, and it is a source of a lot of uncertainty with the assessment. You really can't separate those sources of mortality from those estimates. We just don't have that information. I think it's a good reference point to look at and to monitor going forward; and I think there are studies that are underway to try to get at that question of how to separate mortality sources. But presently it is not possible.

CHAIRMAN CLARK: Do we have any further questions for Brad? Seeing none; thank you very much for the excellent presentation, Brad.

TIMELINE FOR THE SHAD STOCK ASSESSMENT UPDATE

CHAIRMAN CLARK: Our next agenda item is the Timeline for the Shad Stock Assessment Update; which will be given by Jeff Kipp.

MR. JEFF KIPP: I just have a brief update on the next assessment for American shad, which was determined to be an update for 2018. The TC met, and they initially recommended an update of the most recent benchmark stock assessment, which was conducted in 2007. The reason cited for remaining with an update versus a benchmark stock assessment.

The primary reasons were, the short time series of new monitoring efforts that have come online since Amendment 3 was implemented are probably still too short to be used in a benchmark; similar to what we just discussed for river herring at this time. Also another primary reason was the need to develop robust

stock specific ocean bycatch estimates of these mixed stocks out in the ocean interacting with other fisheries.

The proposed timeline is the completion of the assessment for the 2018 August meeting. We just wanted to communicate some challenges experienced while going through the river herring assessment update. There was some committee turnover on the River Herring Stock Assessment Subcommittee; and we expect much more significant committee turnover, pretty much a complete turnover since the shad benchmark assessment.

There is some institutional knowledge lost during that benchmark assessment process. This type of assessment was a lot of consensus building, a lot of expert opinion. Some of that information is lost, and that is what we're trying to update for 2018. Also, there is some change in recommendations on the datasets to be used; based on the change in committee membership. That is another thing that we experienced during the river herring assessment update.

As we went over for river herring, there were several datasets that have been discontinued due to various reasons. We expect to experience that same thing with America shad. Another challenge that we anticipate that is unique to American shad are there are several publications that have come out since the benchmark stock assessment that have questioned the reliability of aging techniques that are used, and have been used historically to age shad with scales. The next steps are that we would like to, now that we've experienced these issues going through the river herring assessment update, and have discussed more internally these issues that we expect to come up with American shad being aging. We feel the need to go back to the Technical Committee and Stock Assessment Subcommittee, and discuss these challenges, and identify how we anticipate to approach this assessment update.

If there are any recommendations for a change to this assessment process, or suggestions of what this assessment update will look like, we plan to bring those forward at the annual meeting and update this Board on those recommendations. That's all I have, and if there are any questions on that.

CHAIRMAN CLARK: Thanks, Jeff. Do we have any questions for Jeff on the shad stock? We have one over there, Rob O'Reilly.

MR. ROB O'REILLY: I've got two questions. The first is the initial slide. You showed the ocean bycatch, so I'm wondering what that's all about. The second question has to do with the peer review of the previous benchmark; and I don't recall how either glowing or what that review was. But I'm wondering about an update, if there were any problems with the peer review from the last benchmark.

MR. KIPP: The ocean bycatch, it's similar to the issue with river herring. There is ocean bycatch of shad and river herring, and those are mixed stocks; these river specific stocks that go out and mix, and are captured by these fisheries. I think we're getting better information on the magnitude of what that ocean bycatch is in more recent years.

But there is also the need to partition that bycatch amongst the river specific stocks. There is recent information and work on doing that for river herring, and partitioning that out by the genetic analyses. But that is a major hurdle to moving to more complex techniques for assessing both shad and river herring.

That's a major hurdle to moving on to a benchmark of American shad; and one of the reasons we decided to stick with an update of the previous assessment. The previous assessment was approved by peer review, and subsequently by this Board. There were probably some recommendations coming out of that by the peer review.

But given that this would be an update assessment, the Stock Assessment Subcommittee would pretty much follow the techniques and use the datasets that were used during that benchmark assessment process; given the process of an assessment update. The opportunity to improve on some of those recommendations from the peer review of the 2007 assessment would likely be implemented in a future benchmark assessment.

CHAIRMAN CLARK: Yes, Rob.

MR. O'REILLY: Just to follow up on the intercept fishery. Do the previous studies assist at all with this delineation of river specific stocks? I realize the study by Bonnie Brown, back maybe around 1990, was a mitochondrial DNA study. There was also a tagging study by Jess Ian from Maryland, and several others back around '91, '92. Is that too far back, or is that any use at all, given that most of the genetic work is now just not mitochondrial DNA alone, but is supplemented by nuclear DNA? How does that all work?

MR. KIPP: I'm not as familiar with those studies, so I would just speak to the primary issue; being we do have some snapshot information on what that ocean bycatch looks like. I think the challenge is developing a time series of that ocean bycatch, partitioned out amongst the stocks and how that changes by year. I think that is one of the bigger challenges for using that information in a more standard or traditional stock assessment model.

CHAIRMAN CLARK: Are there any other questions for Jeff? Loren.

MR. LOREN W. LUSTIG: I appreciate that sir, thank you for your report. My question relates to the hickory shad that runs up the rivers just before the American shad. I have personal experience at the Conowingo Dam at the mouth of the Susquehanna River; and it seems to me their run is at a peak around April 20, the white shad or American shad around April 30. My question is can we extrapolate any trends for the hickory shad based upon the American shad numbers?

MR. KIPP: I don't believe that is something the SAS looked at in depth during the benchmark assessment back in 2007. That would be kind of a new endeavor. I just don't know at this point whether that is something that could be considered to provide information on the American shad trends.

CONSIDER APPROVAL OF SHAD AND RIVER HERRING SUSTAINABLE FISHERY MANAGEMENT PLANS

CHAIRMAN CLARK: Any further questions? Seeing none; thank you, Jeff and we'll move on to our next agenda item, which is Consider Approval of Shad and River Herring Sustainable Fishery Management Plans**.** This is a final action. We'll start with Brad Chase reviewing the SFMPs and Technical Committee Memo for the South Carolina and the Florida Plans.

UPDATE ON SOUTH CAROLINA SFMP

MR. CHASE: I'll start with the blueback herring sustainable fishery plan update for South Carolina; prepared by Bill Post and Chad Holbrook, and reviewed by the TC in March. This plan was first approved in 2011, and it really focused on the commercial fishery in the Santee-Cooper River Complex, as well as small commercial fishery in the Pee Dee River.

The plan 2011 also closed all of the fisheries, and it developed sustainability targets for those two fisheries to remain open; and this was implemented in the 2012 season. It is basically a five-year update. Here is a view of the Rediversion Canal in the Santee-Cooper Complex. Most of the fishing occurs with cast nets. There is a ten bushel daily limit per boat. It occurs in March and April.

It's a fairly focused, traditional fishery that has been going on here for a long time. Here are graphs that show the catch-per-unit effort, and the lower graph shows the man days as well as the landings over time. You can see there have been a few peaks, but a fair amount of fluctuation in recent years.

The sustainability benchmarks are really focused on an exploitation rate that was developed between 1986 and 1990, during a mark and recapture study that looked at total harvest in the mark and recapture estimates for the total numbers of fish in the river. They applied a scaled exploitation rate of 0.05 to present management.

They are proposing to do the same for this update, use that exploitation rate of 0.05. It's a three-year-running average. The graph shows the relative exploitation rate over time, and you can see the metric; and all these years they have been below that. They are proposing to have no change to this benchmark. For the Pee Dee River it is a small commercial fishery with gillnets. It's executed by a small number of permit holders. They have catch limits of 500 kilograms, and they also have a benchmark with a three-year-running average. They are proposing no change to their metrics for this plan update.

I should say in recent years landings have not exceeded a thousand kilograms, so it's a very small fishery. Here is the Pee Dee River harvest in the three-year-running average. You can see there have been a couple years they have exceeded that; again by a small margin, with slightly increasing landings in recent years.

They are collecting fishery dependent biological data as well. They have fork length as well as repeat spawning marks from 2011 to the present. The plans, there is very little change. The catch limits remain the same. They are both using the three-year-running average as their metrics; and they are requesting to have this approved with the same plan as before.

The TC reviewed this and they had a couple comments that I'll share with you. Again, the relative exploitation rate of 0.052 was derived from this 1986 to 1990 mark and recapture estimate. They picked four years and used the lower confidence interval estimates for the total population estimate, and divided that by the harvest; and that produced the relative exploitation rate.

The TC had questions about the data quality using the older data, prior to the present day, and asked if there were conditions that might have changed the applicability of this scalar metric to the present day. The response was that it was really the best available proxy for exploitation rates, and that it was selected to be the lower confidence intervals; so therefore it was quite low and conservative.

Secondly, the TC expressed concerns over the absence of biological metrics; as well as the absence of a secondary sustainability benchmark. They asked for more detail on management responses if they did in fact exceed one of the benchmarks. This was discussed; and the recommendation was that these things would be developed and included in the next update. The TC did approve this plan to move on to the Boards consideration and approval; with the inclusions of the recommendations number too.

CHAIRMAN CLARK: Maybe it would be better to take questions after each review of these plans. Are there any questions about the South Carolina SFMP? Mike Armstrong.

MR. MIKE ARMSTRONG: I guess my only question is based on the TC recommendation, how would we physically approve it and include a mandated recommendation? I don't know how that's done or if we can.

MR. CHASE: Well, in discussion with South Carolina, they were willing to explore adding those features. It really is a question of just having the data developed. I think they have all they need to develop biological metrics; and so I think this can be done. One of the themes that the TC discussed was some of these plans that were approved in that first round, 2010, 2011, was they had management responses listed if a benchmark was exceeded. But they didn't have very much detail to what that response was. That was something the TC was interested in seeing a little more detail in that; maybe some standardization to how these actions occur. Instead of just stating there will be a management response, explicitly outlining what that would be.

CHAIRMAN CLARK: Do we have another question? Andy Shiels.

MR. ANDREW L. SHIELS: I think it was the first graph that showed the catch-per-unit effort was stable but landings were increasing. Is that because there are more people entered the fishery?

MR. CHASE: That is a good question. I would have to defer from somebody from South Carolina who might have that information. I don't know the answer to that.

CHAIRMAN CLARK: Ross, do you have that information?

MR. ROSS SELF: Could you repeat the question?

MR. SHIELS: Sure. I think it was the very first graphic. It showed that catch-per-unit effort was stable, but then landings were increasing. I was just wondering why.

MR. SELF: That's a good question. We've seen some response to environmental conditions. We went through a period of drought. These recent years our runs have increased. I guess we feel like there may be more fish available to that same amount of effort that's being applied.

CHAIRMAN CLARK: Any further questions? Dr. Rhodes.

DR. MALCOLM RHODES: Yes, I can just speak anecdotally. When we've had meetings with the shad river herring fishermen in the area, and they will be the first to admit, when we've had these areas or times of drought there has been very low fish recruitment. Then when we've had years of good-river flow; and you know this is going again anecdotally from the fishermen.

But they will talk for these 20, 30 years; most of these are elderly fishermen. They say when the flows up the fish are in. I think that's where we're getting some of this variation. I bet it correlates very closely, as Ross said with the river flow conditions and times of drought or high water.

MR. SELF: Our folks back home are monitoring our discussion, and they agreed with what I said, by the way that with increased flows we are seeing more fish in the rivers; which is providing more opportunity for that same number of anglers to harvest more fish.

CHAIRMAN CLARK: Given some of the comments we've heard, would the Board prefer to hear both plans and then take motions on approval or do each of these separately? It sounded like there might be some interest in putting some conditions in the motion. Okay, it doesn't look like anybody has got a strong opinion on this.

UPDATE ON FLORIDA SFMP

CHAIRMAN CLARK: Why don't we get the update on the Florida SFMP and then we'll take motions on both.

MR. CHASE: I did just read up on the notes from the last TC meeting that reviewed this.

There was discussion on how flow diversions in that canal can affect catchability; so it does seem to be a factor. Let me run through the American shad sustainable fishery plan with the Florida Fish and Wildlife Conservation Commission for the St. John River. This plan was also first approved by the Board in 2011, and so this is the five-year update. This is strictly for recreational fishing in the St. John River. The 2011 plan used both recreational angler catch-per-unit effort information of 1993 to 2005, it also had a spawning-stock-biomass-abundance estimate they used, and thirdly they had a juvenile abundance index that was used in that fishery management plan.

They proposed in the update to include those data series with a few changes. The present fishery has no commercial harvest, strictly recreational. Pound nets and haul seines were prohibited in the St. John River, and gillnet were prohibited in all state waters in 1995. It is a hook and line recreational fishery only.

Anglers must possess a saltwater fishing license. There is a bag limit of ten Alosa species per person per day, and voluntary catch and release really is the common activity in this fishery. For stock monitoring they have the juvenile abundance index; it's a bow mounted push net. It's been conducted since 2007.

They sample biweekly, April through July between river kilometer 210 and 250, and in tidal and freshwater stretches between river kilometer 125 and 165, so there are two separate sections that they sample for juveniles. Then secondly they have a spawning stock relative index of abundance, its electrofishing survey. It has been conducted since 2003, and it provides a catch-per-unit-effort index, as well as biological samples of length, sex ratio, and age.

Here is the St. John River Complex. You can see there are two highlighted sections in dark blue, above and below this large lake where the sampling occurs for juveniles. Here is where the electrofishing occurs in three river stretches. These are highlighted in blue, and they are separated by quite a large distance.

The creel survey was conducted from 1993 to 2005; it was a roving creel survey in a specific stretch from river kilometer 285 to 298. It was redone in 2011, and I do not believe it is ongoing presently. The two benchmarks are based on the juvenile index as well as the adult index. What they have is a benchmark value; it is based on the 25th percentile, and the management triggers if there are three consecutive years below this benchmark there will be a management response.

Here is a graph showing the juvenile abundance index with that benchmark as the hash line moving across. You can see most of these data points are above that. In recent years several data points are well above that mark, and this is an ongoing series that it will be one of the two benchmarks in the present update. The spawning stock CPUE benchmark, here is a graph depicting the same concept.

The benchmark is shown running across the graph. The data points for the most part are above that. There was discussion on high water impacts of this data series change in catchability; and there was discussion at the TC level of having Florida use a GLM to try to tease out some of these influences of flow, as well as catchability changes along the different locations where they're sampling.

These photos portray what they can find in the St. John River. They have years of extremely low water, where sampling is confined to a very relatively narrow river channel; and then other years at very high water they can have a very wide channel at which they could sample. It certainly can affect catchability in these surveys. The recreational fishery, here is the creel survey results. I think I was mistaken. You can see that it does continue after 2011, so there was a gap

after 2005 to 2010, and it has been resumed, and Florida does seem to want to commit to keeping this series going.

This was reviewed also in March, and the TC again discussed the possibility of looking at it using a GLM to try to gain more information to standardize the data, and to see if we can get at some of these questions on flow influences on catchability in the data series. Florida was interested in exploring that for the next update.

The similar theme came up about having benchmark responses, but without detail as to what those management responses would be. The TC was interested in seeing greater detail and specificity to what would happen if the benchmarks were exceeded. The TC went on to recommend that the Board approve the sustainable fishery management plan with consideration for the improvements discussed in Items 1 and 2 on this slide.

CHAIRMAN CLARK: Any questions about the Florida SFMP? Seeing none; oh, I'm sorry, Rob O'Reilly.

MR. O'REILLY: I guess I was just curious about the push net sampling; because that occurred in some Virginia rivers. Is that a nighttime sampling?

MR. CHASE: It typically is. In this case I don't think I have that information if it is or not, so I would have to ask Florida if it is in fact nighttime sampling.

MR. CLARK: Jim, do you want to answer that?

MR. JIM ESTES: Yes, it typically is.

MR. CLARK: Any further questions? Seeing none; would somebody like to put forth a motion to approve these plans? Mr. Estes.

MR. ESTES: I move to approve South Carolina's sustainable fishery management plan for river herring and the Florida sustainable fishery management plan for shad; inclusive of TC recommendations.

MR. CLARK: We have a second by Dr. Rhodes. Let's wait until we have the modified motion up there. The motion is to move to approve the South Carolina sustainable fishery management plan for river herring, and the Florida sustainable fishery management plan for shad; inclusive of the Technical Committee recommendations. Do we have any discussion on this motion? Rob O'Reilly.

MR. O'REILLY: Given Mike Armstrong's comments earlier. Can we see what the second item was for South Carolina that was coming from the Technical Committee, and make sure it's a recommendation?

CHAIRMAN CLARK: Can we get that back up? Do you want to amend the motion, Rob?

MR. O'REILLY: No that's fine; I just needed to see that again. Thank you.

CHAIRMAN CLARK: **Any further discussion of the motion? Seeing none; are there any objections to the motion? Seeing none; the motion is approved by unanimous consent and that concludes Item Number 6.**

REVIEW OF THE FMP REVIEW AND STATE COMPLIANCE REPORTS FOR 2017

CHAIRMAN CLARK: And we move on to Item 7, and Kirby will be giving us a review of the FMP review and state compliance reports for 2017**.** This is also an action item.

MR. KIRBY ROOTES-MURDY: I'm subbing back in on shad and river herring and trying to get up to speed as much as possible; so please bear with me as I go through the fishery management plan review. We have landings information here. As you all are aware there has been a steady increase in landings over

time; in part due to the moratoria implemented through Amendments 2 and 3.

States with shad commercial landings are New Jersey, Virginia, North Carolina, South Carolina and Georgia and states with river herring commercial landings are Maine, New Hampshire, New York, Maryland, North Carolina and South Carolina. In 2015 a total of 478,688 pounds of American shad were landed; which was about a 38 percent decrease from 2014 levels.

In 2015 about two million pounds of river herring were landed, which is a 9 percent increase from 2014 levels, and 153,000 pounds of hickory shad were landed, which is an approximate 29 percent increase from 2014 levels. States with the largest shares of shad landing are North Carolina and South Carolina, and the state with the largest share of river herring landings is Maine.

Moving on to river herring passage counts, Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, Pennsylvania, Maryland and South Carolina all have projects in place. Coastwide 3.82 million river herring passed through and were counted this year. Coastwide total of 611,000 American shad were counted as having passed through.

In terms of how these fare relative to 2014 numbers, it is about a 26 percent increase for river herring, and it's about a 43 percent increase for shad. There are also coastwide stocking projects occurring in Maine, Massachusetts, Rhode Island, Pennsylvania, Maryland, the District of Colombia, Virginia, North Carolina and South Carolina.

In total 21 million hatcheries Alosine were reintroduced in 2015. River herring is stocked in lakes and river basins in Maine, but they are wild caught, so they are not hatchery raised; and that's why we don't have any specific information included in the FMP review on that.

Brad went through earlier the sustainable fishery management plans that this board has reviewed at the beginning of the year.

I wanted to give you all just kind of an outline of what to expect for the annual meeting. Today this Board approved the South Carolina river herring and the Florida shad SFMPs. There will be a number of SFMPs that the Technical Committee is going to need to review over the next month or so.

I know that Ashton had sent out before a request for states to submit that information by August 30, and I would request that you try to do that sooner if possible, because as you can see we have five that the TC is going to need to review and provide recommendations to the Board on at the ASMFC annual meeting. Another component of the FMP review is reporting out sturgeon interactions. In 2015, 196 interactions were reported, 176 of those were Atlantic sturgeon, and 20 were short-nosed sturgeon. These took place in Rhode Island, Connecticut, New Jersey, Virginia, North Carolina, South Carolina and Georgia.

All were released alive with the exception of 15 fatalities that took place in North Carolina. Last, there were de minimis requests from the states of Maine, New Hampshire, Massachusetts, and Florida for American shad and for New Hampshire and Florida regarding river herring; and all these states meet the requirements for de minimis. With that I will take any questions.

CHAIRMAN CLARK: Thanks, Kirby. Do we have any questions for Kirby? Lynn Fegley.

MS. LYNN FEGLEY: Just a couple things for the record. I just wanted to correct that the state of Maryland is closed for the commercial harvest of river herring. I think that might have been PRFC, and also I do not believe that we're doing any run counts in the state of Maryland; so just for the record.

CHAIRMAN CLARK: Thanks, Lynn, also Delaware does have a shad stocking program. Are there any other questions or comments on the FMP review? Seeing none; do we have a motion, or do we need a motion for this? Okay, we have a motion, Mike Armstrong.

MR. ARMSTRONG: **Move to approve the 2016 FMP Review of the 2015 fishing year, and approve de minimis requests from Maine, New Hampshire, Massachusetts, and Florida for shad, and de minimis requests for New Hampshire and Florida for river herring.**

CHAIRMAN CLARK: Do we have a second? Cheri Patterson. Okay, do we have any discussion of this motion? Seeing none; do we have any objection to the motion? Seeing none; let me read it into the record. It is move to approve the 2016 RMP Review of the 2015 fishing year, and approve de minimis requests for Maine, New Hampshire, Massachusetts, and Florida for shad, and de minimis requests for New Hampshire and Florida for river herring.

Motion by Mr. Armstrong, second by Ms. Patterson, and seeing no objections the motion is passed by unanimous consent.

ADJOURNMENT

CHAIRMAN CLARK: Okay that brings us up to Item Number 8, Other Business. Is there any other business to come before this Board? Seeing none; we are adjourned, and we finished an hour early, so Eel will be starting before ten o'clock, so don't go too far. Thank you.

(Whereupon the meeting was adjourned at 9:00 o'clock a.m. on August 2, 2017.)

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Atlantic States Marine Fisheries Commission

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MEMORANDUM

TO: **Shad and River Herring Management Board**

FROM: **Caitlin Starks, FMP Coordinator**

DATE: **September 27, 2017**

SUBJECT: **Summary of Shad and River Herring Advisory Panel Conference Call**

This memorandum summarizes the topics and discussions during the Shad and River Herring Advisory Panel (AP) call on Wednesday, September 27th 2017 at 9:00 am. The meeting took place via conference call and webinar and provided the AP to review and discuss several items including the recent 2017 stock assessment update for river herring, NOAA's status review for river herring to consider ESA listing, continued state efforts in alosine monitoring and restoration, and updated sustainable fishery management plans (SFMPs) that will be reviewed by the Board at the annual meeting.

AP Members in attendance: Pam Lyons Gromen (Chair), Byron Young, Allison Bowden, Jeff Kaelin

ASMFC Staff: Caitlin Starks, Kirby Rootes-Murdy

Public: Erika Fuller (Earthjustice), Ansley Samson (NRDC), Shaun Gehan

1) Review the 2017 River Herring Assessment Update

An overview of the 2017 River Herring Assessment Update was presented by Jeff Kipp. The presentation included background information, updated trends, and concluding thoughts. The following key points that were highlighted:

- The update used a trend analysis approach incorporating data through 2015
- 26% of 57 total rivers systems had sufficient data to use in the analysis
- There was high variability in trends across the Atlantic coast
- River specific abundance showed 16 increasing trends, 2 decreasing, 8 with no significant trend and 18 without sufficient data
- The increasing trends seem to be more prevalent in the Northeast, with more variability in the mid and south Atlantic.

Questions were raised regarding the absence of known Hudson River data sets from the assessment update, the method by which abundance trends were determined, the reason behind changes in the sex composition of repeat spawners, and whether the long-term coast wide trends in length composition and length at age are cause for concern. Given that many of the data sets come from runs in the Northeast, does this potentially mask problems in Mid and South Atlantic runs when reporting trends on a coast wide basis? Climate change studies regarding changes in fish distribution have concluded that the center of biomass for many east coast fish stocks is shifting north. How or does this affect river herring abundance trends?

The AP members commented on the data limitations of the update, and while recognizing that the update was constrained to using data sets included in the benchmark assessment, see the potential to incorporate new data in future assessments and the upcoming NOAA status review for river herring. The group also discussed the challenge of gathering more information given that moratoria resulted in the loss of much fishery dependent data.

2) Update on NOAA's status review of river herring

ASMFC Staff provided a brief overview of the process and timeline of the NOAA status review to consider ESA listing for river herring, including the following points:

- NOAA announced the status review for alewife and blueback herring in a federal register notice on August 15, 2017
- At that time, NOAA opened a 60-day public comment period to solicit information to support our status review. The information solicitation period ends on October 16, 2017.
- NOAA plans to use the recent ASMFC Alewife and Blueback Herring Stock Assessment Update from August 2017 as part of the status review.
- Timeline:
    - Status Review- present to early 2018
    - Extinction Risk Assessment- Spring 2018
    - Peer Review of Status Review and Extinction Risk Assessment- Summer 2018
    - Listing Determination- published by January 31, 2019

The AP was in agreement that the usefulness of the stock assessment update for the status review was limited since a number of research studies and data sets were excluded from the update because they did not fit within the original framework of the last benchmark assessment. The group mentioned a number of initiatives they hoped would be part of the status review, including portside and electronic monitoring of at-sea catch, the Northeast Fisheries Science Center Climate Vulnerability Assessment and research stemming from the Technical Expert Working Group and the River Herring Conservation Plan. –

The AP members asked if the River Herring Technical Expert Working Group (TEWG) will be submitting information for the review. Allison Bowden, who is a TEWG member, commented that much of the research that has been done by the TEWG has been directed at this status review, and is submitted to NOAA. Independent research will also be submitted by various other members.

Pam Lyons Gromen commented that it seems there is still a lot of uncertainty about at-sea catch of river herring and how this impacts the stocks given very low levels of observer coverage in federal mid-water trawl fisheries for herring and mackerel in recent years; this should be considered in the review as well. Jeff Kaelin and Alison added that data from portside and electronic monitoring studies are currently not considered in incidental catch analyses reported to managers and that these studies should not be overlooked for the status review.

The AP agrees it would be good for ASMFC to encourage TC members to submit data pertaining to shad and river herring to NOAA for the status review. The ASMFC should keep an inventory of information that TC members contribute.

3) Discussion on recent observations and experiences with state river herring & shad runs and restoration efforts

Byron Young updated the AP on the voluntary program in Long Island, coordinated and supported by the Seatuck Environmental Association in Islip, which looks for remnant river herring runs in small coastal streams. This has been an ongoing program for almost a decade. The program has identified 26 streams around Long Island and New York City that support some alewife runs, and these runs could be improved through dam removal or implementing fish passages. 17 fish passage efforts have been completed so far. Where larger runs are occurring, spawning fish are moved upstream.

Brad Schondelmeier was on the agenda to give a presentation on the Portside Sampling Program in Massachusetts, but was unable to attend the call. His presentation will be shared with the AP.

4) Discuss Shad SFMPs up for approval

ASMFC Staff gave a short overview of the Sustainable Fishery Management plans for American Shad that the board will review for approval in October 2017. Connecticut, the Potomac River Fisheries Commission, North Carolina, South Carolina, and Georgia have all submitted updated SFMPs for approval. Virginia has submitted a proposal for a limited bycatch allowance.

The TC has reviewed all of these plans except for South Carolina and Georgia, which they will review in an upcoming call. There is a concern that a few plans include several rivers for which there is no monitoring but recreational fisheries are permitted to occur. The recreational fisheries are believed to be insignificant, but there are no data to support this claim in the SFMPs. The AP agrees that all rivers with any directed fishery for shad or river herring should have required monitoring to verify that significant harvest is not occurring or that harvest meets the IFMP criteria for sustainability. More information on the type of recreational fishing that is occurring on these rivers (e.g. type of gear or size of tackle) could be beneficial to understand whether shad and river herring would be caught in the fishery.

5) Future meeting schedule and goals

The AP discussed a timeline for meeting, and agreed that the group would benefit from meeting at least once per year. September or October is a good time to meet because the AP will be able to receive new information through compliance reports and the FMP review and provide any comments to the Board for the annual meeting. The AP would like to be brought into any discussions on important changes in the fishery, and notified of upcoming Board meetings. The AP noted the low turnout and response to the webinar invitation and is hopeful that more regular communication will reinvigorate AP membership.

MARYLAND - VIRGINIA
"Potomac River Compact of 1958"

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Potomac River Fisheries Commission's

American Shad

Sustainable Fishery Management Plan

Submitted to the
Atlantic States Marine Fisheries Commission

August 11, 2017

1. Sustainable Fishery Plan

In accordance with the guidelines provided in Amendment 3 to the Interstate Fishery Management Plan (IFMP) for Shad and River Herring, the Potomac River Fisheries Commission (PRFC) submits the following American Shad Sustainable Fishery Plan.

1a. Request for Fishery

The PRFC requests that the Shad and River Herring Management Board consider this request to continue a limited commercial by-catch allowance of American shad in the portion of the Potomac River under PRFC jurisdiction (Figure 1). Accordingly, the PRFC justifies this request based on the fact that the Board accepted the 2007 Shad Stock Assessment which established a benchmark goal for American shad recovery in the Potomac River and required the PRFC to continue monitoring the pound net fishery's by-catch allowance of American shad, including discards. The Stock Assessment stated "to continue stock rebuilding, there should be no new expansion of the fishery until the benchmark is reached". The benchmark goal identified in the 2007 Stock Assessment was approved as a restoration target and has been exceeded each year since 2011 (Figure 2).

1b. Definition of Sustainability

Amendment 3 to the IFMP for Shad and River Herring defines a sustainable fishery as one that will not diminish potential future stock reproduction and recruitment. The PRFC proposes to continue with the mandatory daily harvest reporting program with the fishermen on the Potomac River, in which they record daily harvest, effort and discard data. The continuation of this data collection enhances the long term data set that the PRFC maintains, updates and utilizes to monitor the progress of the American shad stock rebuilding and recovery in the Potomac River. The long-term American shad juvenile abundance index (JAI) for the Potomac River is provided by Maryland Department of Natural Resources (MD DNR) and will continue on an annual basis (Figure 3).

1c. Summary of current stock status

The Potomac River has been closed to the commercial and recreational directed harvest of American shad since March 1, 1982. The only allowable commercial harvest since then has been via a pound net by-catch provision that allowed up to two percent by volume of the total catch in possession to be American shad. Starting in 1996, the pound net by-catch provision was further limited to two percent by volume, but could not exceed one bushel per day per licensee. In 2004, a one-bushel limit of American shad by-catch for the gill net fishery was approved by the ASMFC Shad and River Herring Technical Committee and Board, and established by the PRFC. In 2012, ASMFC approval was obtained to increase the by-catch limits from one bushel to two bushels per day per licensee for pound nets and gill nets. Currently in the Potomac River, all directed commercial, recreational and charter boat fisheries for American shad remain closed.

1d. Benchmark goals and objectives or restoration goals/targets

In the 2007 ASMFC Shad Stock Assessment, a benchmark for American shad in the Potomac River was defined as the geometric mean (GM) CPUE of pound net landings reported in Walburg and Sykes (1957) for the years 1944 to 1952, or 31.1 pounds per net-day. It was concluded in the assessment that among Chesapeake Bay stocks of American shad, the Potomac River

population showed the most promising signs of recovery. The gill net index, the pound net index, and the JAI depicted strongly increasing trends in relative abundance. To continue stock rebuilding in the Potomac River, it was recommended that there should be no new expansion of the fishery until the benchmark goal is reached, and that this requires continued monitoring of the pound net fishery, including discards.

The ASMFC Shad and River Herring Management Board accepted the 2007 Shad Stock Assessment Report, which included the Potomac River benchmark. This benchmark goal of 31.1 became the restoration target for the Potomac River and was approved by the ASMFC Shad and River Herring Technical Committee. The GM was calculated for CPUEs of total pound net data (catch + discards) and the GM exceeded the benchmark goal and restoration target in 2011 with a value of 32.0 pounds per net-day (Figure 2). The GM has increased every year since 2002, so achieving the target in 2011 was not unexpected; however, we have continued to exceed the restoration target each year. The PRFC has reported this information in their annual compliance report.

1e. Proposed time frame for achievement

The benchmark goal identified in the 2007 Stock Assessment and approved as a restoration target was first exceeded in 2011, and continues to be exceeded each following year.

1f. Discussion of management measure(s) to be taken if sustainable target is not achieved within indicated timeframe

The restoration target in the Potomac River was achieved in 2011, and continues to be exceeded during each of the following years. The PRFC will continue monitoring the total pound net CPUE data as well as the MD DNR survey data.

If the GM for CPUEs of the total pound net data (catch + discards) drops below the restoration target for three consecutive years, then the PRFC will consider potential restrictions including: reducing or eliminating the two bushel by-catch allowance for pound nets and gill nets; and limiting or restricting the take of broodstock / egg collections by other agencies for shad restoration projects.

2. Stock Monitoring Programs

2a. Fishery Independent

American shad have been taken from the Potomac River as brood stock for hatchery production by several agencies under special collection permits issued by the PRFC since 1995. The Interstate Commission on the Potomac River Basin (ICPRB), participated in the Potomac Restoration Stocking Program for American shad from 1995 – 2002, at which time recovery was considered sufficient for natural reproduction. In 2003, restoration stocking of the Rappahannock River started using Potomac River origin eggs through a partnership between ICPRB, the Virginia Department of Game and Inland Fisheries (VDGIF), and the U. S. Fish & Wildlife Service (USFWS) Harrison Lake National Fish Hatchery. Stocking of the Potomac River continues, but now as “replacement stocking” to account for the Potomac shad sacrificed for another river system. Since 1995, the ICPRB has released over 22 million fry into the Potomac. ICPRB continues to collect some American shad each year from the Potomac River for their schools and educational components, and incorporates significant public involvement into this project with a “Schools-in-Schools” partnership. In 2017, volunteers helped over 1,300 students from 28

Washington metropolitan area schools hatch shad in their classrooms and stock them in the Potomac and Anacostia Rivers. The students' efforts to help replenish American shad populations are notable, but more important is the link between students, volunteers, the river, watermen, biologists and our shared fishery heritage.

The Maryland Department of Natural Resources (MD DNR) (since 2001), VDGIF (2003 – 2009, and 2017), the USFWS (since 2004) and the District of Columbia's Fisheries and Wildlife Division of the Department of Energy and Environment (DOEE) (since 2005) have all collected American shad for brood stock under special collection permits issued by this Commission. The PRFC's Scientific Collection Permits require data reports, and scale/otolith samples of ten percent of the "kept" American shad for analysis, together with their length, weight and sex. In addition, ten to fifteen percent of all shad fry resulting from the use of this permit are to be restocked in the Potomac River as close to the capture site as is feasible.

The MD DNR began replacement stocking in 2007, and has released about 1.4 million fry into the Anacostia River, a tributary of the Potomac River in Washington D.C. and 1.2 million fry into the Potomac River. The DOEE has released approximately 8.6 million fry into the Anacostia River. The VDGIF reported a total of 4.6 million fry stocked in the Potomac, and the USFWS reported 902,000 fry stocked in the Potomac River as mitigation for egg collections. In addition, the USFWS released approximately 2.2 million viable eggs back into the Potomac River for mitigation. The Potomac River has been the egg source for all of Maryland's shad restoration projects, Virginia's shad restoration program in the Rappahannock River, as well as the Susquehanna River (MD/PA) and some of Delaware's rivers since 2002.

i. Juvenile abundance indices

Maryland is required to provide an American shad juvenile index for the Potomac River and several other river systems throughout its portion of the Chesapeake Bay. The annual juvenile abundance survey has been conducted since 1954, with American shad data collected from 1959 to present. Fixed stations and some auxiliary stations are used each year for a beach haul seine survey in which the juveniles of all species encountered are identified and recorded. The American shad juvenile index for the Potomac River is derived from the Maryland DNR state wide annual young of the year survey as geometric mean CPUEs (Figure 3). The 2016 value of 3.84 was significantly lower than the 2015 value of 19.81, which was a record high value. http://www.dnr.state.md.us/fisheries/juvindex/index.html

ii. Adult stock monitoring

Durell and Weedon (2015) report that Maryland DNR has conducted a Striped Bass Spawning Stock Survey since 1985, using multi-panel drift gill nets in the Potomac River. Since 1997, adult American shad that were incidentally caught were processed to obtain length, sex and age (scale samples) and repeat spawning determination (Figure 4).

2b. Fishery Dependent

i. Commercial Fishery

The non-directed Potomac River pound net by-catch harvest in 2016 consisted of 1,145 pounds of American shad (Table 1). The PRFC's mandatory commercial daily harvest reporting system is the source of these data, collecting harvest as well as discards or released fish. The 2016 discards/released by-catch of American shad in excess of the daily landing limit from pound nets was 3,500 pounds. The 2016 pound net harvest data was combined with the 2016 pound net discard data to identify the total CPUE. There were 4 pounds of American shad reported as

harvested by gill nets and 2 pounds of gill net discards in 2016.

Pound net effort is expressed as “pound net fishing day” which is one net fished one time. During 2016, one hundred pound nets were licensed in the Potomac River; however only a few of them were set during the early spring months (the shad run). The pound net fishery is a ‘limited entry’ fishery capped at 100 licenses (each net is licensed separately). Effort included 50 pound net fishing days for the American shad by-catch harvest.

Regulation effective January 1, 2011 – all pound nets in the Potomac River must have at least six PRFC approved fish cull panels properly installed in each pound net to help release undersize fish. This regulation will have a beneficial impact on the release of river herring, but will not be effective in the release of adult shad. These fish cull panels were being used for by-catch reduction by some pound netters on a voluntary basis prior to 2011; they are now mandatory.

ii. Recreational Fishery

The Potomac River, under PRFC jurisdiction, recreational and charter boat fisheries for American shad remained closed in 2016. The American shad fishery has been closed since 1982 in this portion of the Potomac River. We are unaware of any historical or current recreational activity within the PRFC’s jurisdiction. A historical recreational fishery existed in the D.C. portion of the Potomac River, but that fishery is now closed.

Literature Cited

Durell, E. Q. and C. Weedon. 2015. Striped Bass Seine Survey Juvenile Index Web Page. http://dnr2.maryland.gov/fisheries/Pages/juvenile-index.aspx. Maryland Department of Natural Resources, Fisheries Service.

Walburg, C. H. and J. E. Sykes. 1957. Shad fishery of Chesapeake Bay with special emphasis on the fishery of Virginia. U.S. fish Wildlife Service, Research Report 48, 26 p.

Figure 1. Potomac River – PRFC jurisdiction is the main stem of the Potomac River downstream of Washington, DC

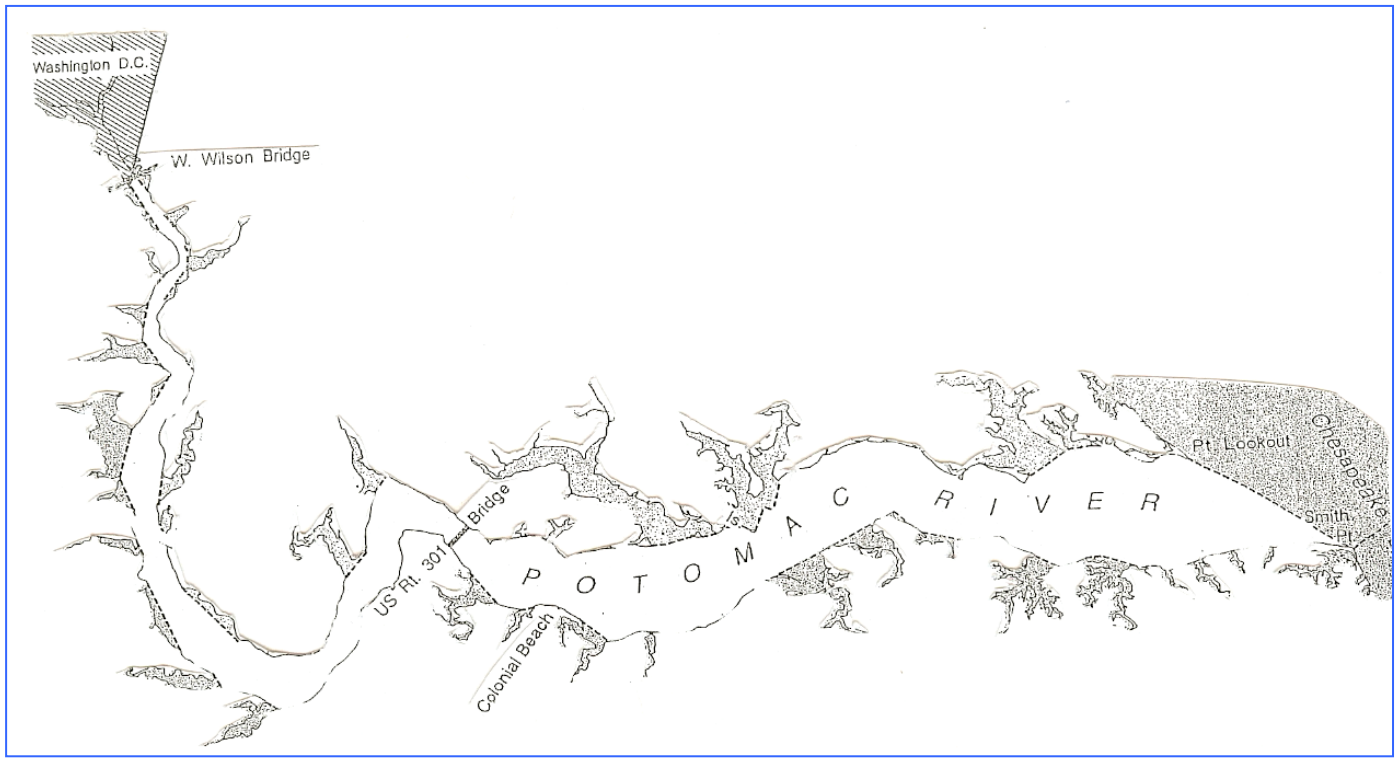
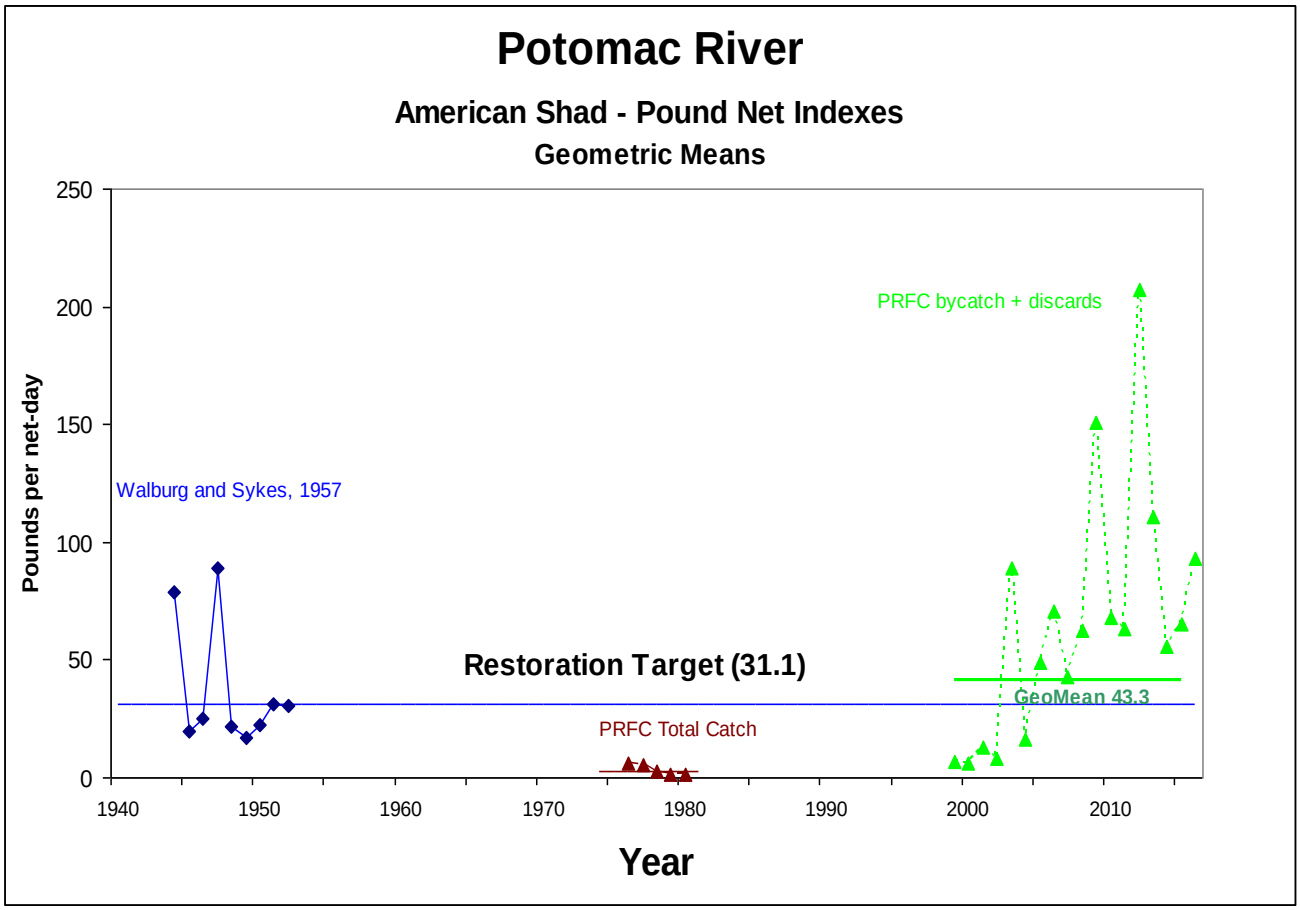


Figure 2

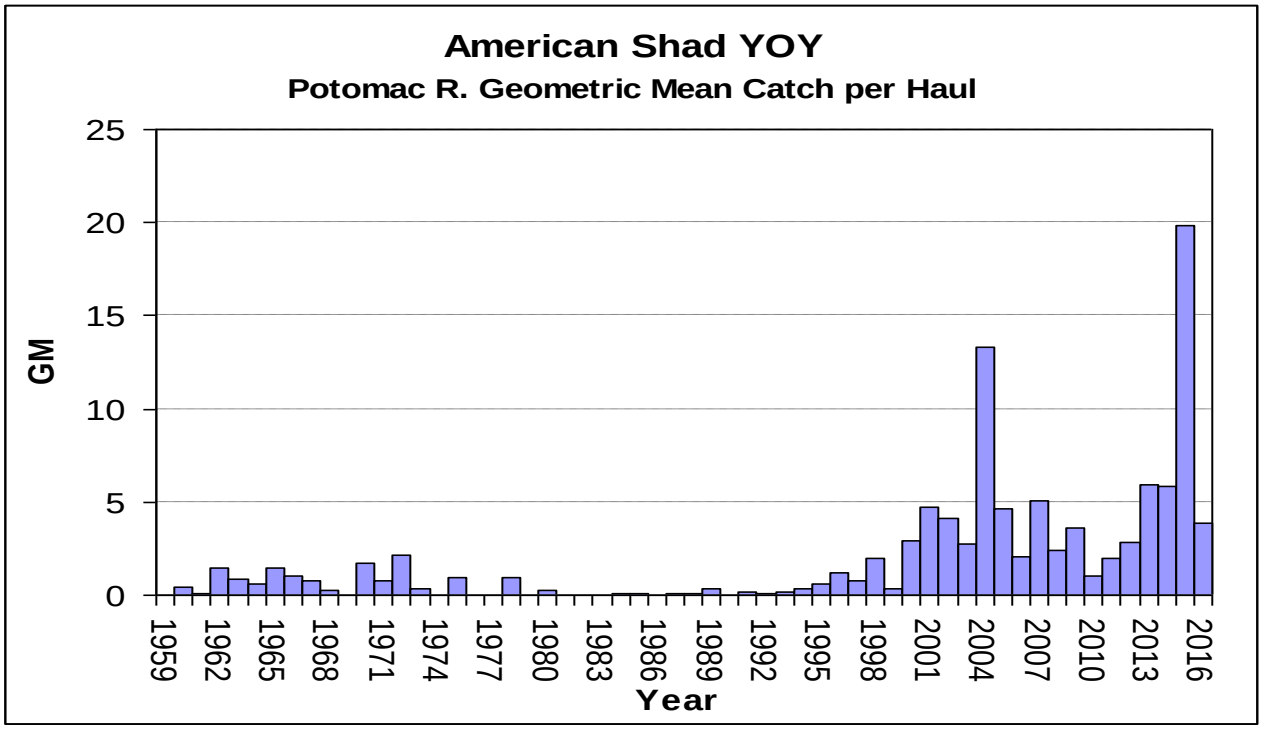


Source: PRFC

Geometric Mean (GM) of Pound Net CPUE Data												
Time Series	1944-1952	1976-1980	1999-2002	1999-2003	1999-2004	1999-2005	1999-2006	1999-2007	1999-2008	1999-2009	1999-2010	1999-2011
GM	**31.1**	3.0	8.1	13.1	13.6	16.3	19.6	21.3	23.8	28.1	30.2	32.0

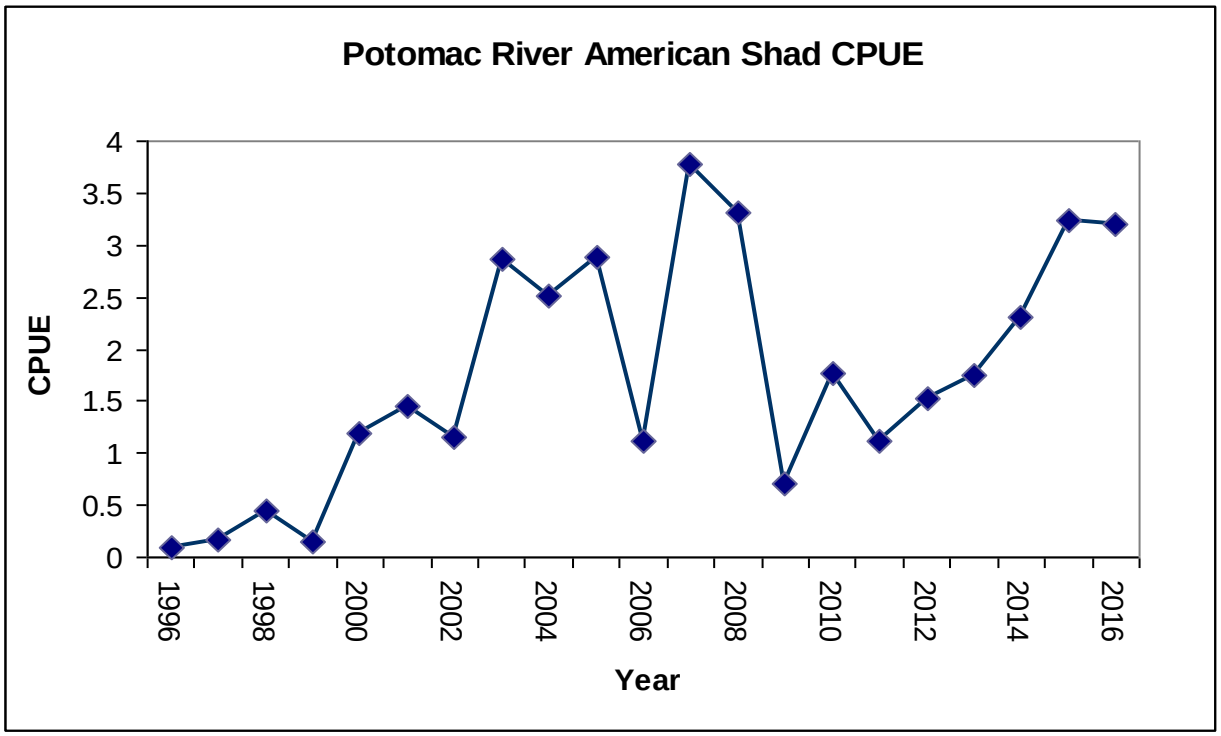
Geometric Mean (GM) of Pound Net CPUE Data												
Time Series	1999-2012	1999-2013	1999-2014	1999-2015	1999-2016							
GM	36.6	39.4	40.3	41.4	43.3							

Figure 3



Source: http://dnr2.maryland.gov/fisheries/Pages/striped-bass/juvenile-index.aspx

Figure 4



Effort corrected catch of American shad on the Potomac River during the MD DNR striped bass spawning stock survey. CPUE is standardized as the number of fish caught per 1000 square yards of drift gill net per hour. Source: MD DNR

Table 1 POTOMAC RIVER FISHERIES COMMISSION
AMERICAN SHAD
Commercial Harvest (pounds) and Discard (pounds)

	HARVEST					DISCARD							PN CPUE C+D
Year	Pound Net				Gill Net	Pound Net		Gill Net		Other Gear		Total	
	Roe	Buck	Total	Net-days	Total	Roe	Buck	Roe	Buck	Roe	Buck		
1988	766	1,128	1,894	2,021									
1989	543	525	1,068	1,574									
1990	1,299	983	2,282	1,361									
1991	1,062	856	1,918	1,208									
1992	939	526	1,465	703									
1993	1,480	1,447	2,927	611									
1994	677	628	1,305	758									
1995	1,458	1,180	2,638	743									
1996	1,357	935	2,292	553									
1997	2,773	2,310	5,083	737									
1998	1,680	571	2,251	335									
1999	1,049	917	1,966	388		376	213	14	10			613	6.59
2000	897	611	1,508	258		28	56	55				139	6.17
2001	3,347	1,492	4,839	433		800	56	53		25		934	13.15
2002	1,727	1,035	2,762	348			59	25	2			86	8.11
2003	6,971	1,170	8,141	547		22,790	17,566	9,393	670	204	73	50,696	88.66
2004	4,408	643	5,051	493	293	1,800	1,100	1,053	54			4,007	16.13
2005	5,255	764	6,019	493	801	15,171	3,008	170	0			18,349	49.08
2006	3,847	409	4,256	260	413	10,178	4,000	17	4			14,199	70.90
2007	5,662	942	6,604	388	2,310	8,622	1,323	90		4		10,039	42.65
2008	6,310	505	6,815	274	160	8,282	2,000					10,282	62.40
2009	4,402	603	5,005	197	209	19,150	5,500			2		24,652	150.53
2010	3,790	95	3,885	117	31	3,907	131					4,038	67.72
2011	2,167	252	2,419	77	0	2,015	450					2,465	63.43
2012	2,478	1,641	4,119	177	623	21,515	11,040			4		32,559	207.20
2013	2,943	853	3,796	110	3	4,150	4,250	3				8,403	110.87
2014	2,822	1,181	4,003	80	10	320	106	13		24	10	473	55.95
2015	1,135	754	1889	58	12	1,700	200			86	3	1,989	65.12
2016	556	589	1145	50	4	3,500		2				3,500	92.90

Source: PRFC

Table 2. USFWS - Summary of American Shad collected and Eggs Produced from the Potomac River

	2004	2005	2006*	2007*	2008*	2009*	2010*	2011*	2012*	2013*	2014*	2015*	2016*	Totals
# Females Caught			673	1,110	1,291	451	1,569	1,021	1,611	1,732	2,277	2,456	1,637	15,828
# Males Caught			117	272	284	510	1,196	404	475	266	758	284	331	4,897
Ripe Females	50			515	501	451	955	368	712	539	1090	793	702	6,676
Ripe Males	39			271	284	510								1,104
# Shad Released	125		395	596	790	787	614	652	899	1,193	1,187	1,663	935	9,836
Total Shad Kept	89		382	786	785	771	2,151	772	1,187	805	1,848	1,077	1,033	11,686
Total Shad Caught	214	296	777	1,382	1,575	1,558	2,765	1,425	2,086	1,998	3,035	2,740	1,968	21,819
Avg.CPUE (shad/hr/ft^2)			0.001	0.002										
Volume(L) of Eggs			99.3	183.9	194.4	132.2	375.0	137.4	258.0	118.1	316.7	170.5	165.6	2,151
# of Eggs			4,511,426	7,488,716	8,503,709	6,380,784	17,843,432	6,216,484	11,183,457	7,512,761	14,407,614	8,850,523	8,385,914	101,284,820
Viable Eggs			2,003,222	2,875,455	3,491,069	1,885,500	6,874,612	2,714,435	5,664,920	1,603,498	5,671,992	2,044,013	2,138,510	36,967,226
Viablility (%)			44%	42%	41%	30%	39%	44%	51%	21%	39%	23%	25%	
# Fry stocked				259,119	188,739		365,000	90,000						902,858
Viable Eggs stocked									670,292	277,864	555,650	298,476	155,125	1,957,407

* Scales & otoliths taken on 5% of fish

American Shad Age, Length, and Weight
Potomac River - 2015 (USFWS)

Year Class	**2008**	**2009**	**2010**	**2011**	**Total**
Age	**7**	**6**	**5**	**4**	
Males					
Number	4	2	4	0	10
% by year class	40%	20%	40%	0%	
Av. TL (mm)	489	484	475		
Av. Wt. (kg)	1.02	0.94	0.96		
Females					
Number	5	17	16	2	40
% by year class	12%	42%	40%	5%	
Av. TL (mm)	512	499	495	470	
Av. Wt. (kg)	1.43	1.27	1.20	0.98	
Sexes Combined					
Number	9	19	20	2	50
% by year class	18%	38%	40%	4%	
Av. TL (mm)	502	497	494	470	
Av. Wt. (kg)	1.25	1.24	1.15	0.98	

American Shad Age, Length, and Weight
Potomac River - 2014 (USFWS)

Year Class	**2007**	**2008**	**2009**	**2010**	**Total**
Age	**7**	**6**	**5**	**4**	
Males					
Number	7	21	12	1	41
% by year class	17%	51%	29%	2%	
Av. TL (mm)	490	482	404	478	
Av. Wt. (kg)	1.04	1.02	0.97	0.85	
Females					
Number	11	18	12		41
% by year class	27%	44%	29%		
Av. TL (mm)	519	516	502		
Av. Wt. (kg)	1.21	1.26	1.24		
Sexes Combined					
Number	18	39	24	1	82
% by year class	22%	48%	29%	1%	
Av. TL (mm)	508	498	453	478	
Av. Wt. (kg)	1.14	1.13	1.10	0.85	

American Shad Age, Length, and Weight
Potomac River - 2016 (USFWS)

Year Class	**2008**	**2009**	**2010**	**2011**	**2012**	**Total**
Age	**8**	**7**	**6**	**5**	**4**	
Males						
Number		1	1	2	1	5
% by year class		20%	20%	40%	20%	
Av. TL (mm)		514	479	462	382	
Av. Wt. (kg)		1.04	0.88	0.52	0.46	
Females						
Number	1	5	11	17	1	35
% by year class	2.8%	14.3%	31.4%	48.6%	2.8%	
Av. TL (mm)	540	532	507	451	470	
Av. Wt. (kg)	1.34	1.23	1.18	1.02	0.96	
Sexes Combined						
Number	1	6	12	19	2	40
% by year class	2.5%	15%	30%	47.5%	5%	
Av. TL (mm)	540	529	505	452	426	
Av. Wt. (kg)	1.34	1.20	1.15	0.97	0.71	

Table 3. MD DNR AMERICAN SHAD MITIGATION REPORT - POTOMAC RIVER

Species	Year	Date	River	Stocking site	Number	Cultured By:	Stocked For:
American Shad	2007	5/15/07	Potomac	Anacotia	200,000	DC Fisheries	MD DNR mitigation
American Shad	2008	4/24/08	Potomac	Anacotia	170,000	DC Fisheries	MD DNR mitigation
American Shad	2008	5/12/08	Potomac	Anacotia	30,000	DC Fisheries	MD DNR mitigation
American Shad	2009	5/6/09	Potomac	Anacotia	200,000	DC Fisheries	MD DNR mitigation
American Shad	2010	n/a	Potomac	Anacotia	400,000	DC Fisheries	MD DNR mitigation
American Shad	2011		Potomac	Marshal Hall	263,000	MD DNR	MD DNR mitigation
American Shad	2012	4/16/12	Potomac	Marshal Hall	165,000	MD DNR	MD DNR mitigation
American Shad	2012	4/5/12	Potomac	Anacostia	200,000	DC Fisheries	MD DNR mitigation
American Shad	2013	5/1/13	Potomac	Anacostia	200,000	DC Fisheries	MD DNR mitigation
American Shad	2013	4/29/13	Potomac	Marshall Hall	3,000	MD DNR	MD DNR mitigation
American Shad	2013	5/10/13	Potomac	Marshall Hall	220,000	MD DNR	MD DNR mitigation
American Shad	2013	5/21/13	Potomac	Marshall Hall	57,400	MD DNR	MD DNR mitigation
American Shad	2014	4/14/14	Potomac	Marshall Hall	10,300	MD DNR	MD DNR mitigation
American Shad	2014	4/16/14	Potomac	Marshall Hall	20,700	MD DNR	MD DNR mitigation
American Shad	2014	4/23/14	Potomac	Marshall Hall	10,300	MD DNR	MD DNR mitigation
American Shad	2014	5/8/14	Potomac	Marshall Hall	31,000	MD DNR	MD DNR mitigation
American Shad	2014	5/16/14	Potomac	Marshall Hall	20,700	MD DNR	MD DNR mitigation
American Shad	2014	4/29/14	Potomac	Marshall Hall	166,000	DC Fisheries	MD DNR mitigation
American Shad	2015	4/24/15	Potomac	Marshall Hall	10,800	MD DNR	MD DNR mitigation
American Shad	2015	5/7/15	Potomac	Marshall Hall	172,700	MD DNR	MD DNR mitigation
American Shad	2016	4/13/16	Potomac	Marshall Hall	30,800	MD DNR	MD DNR mitigation
American Shad	2016	4/26/16	Potomac	Marshall Hall	30,800	MD DNR	MD DNR mitigation
					2,612,500		

Table 4. Summary of American Shad Collected from the Potomac River by MD DNR and Eggs Obtained

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
# Ripe Females	298	568	458	231	561	472	567	401	425	599
# Green Females		205	351	276	446	314	438	405	277	288
# Spent Females		147	60	183	192	98	178	141	144	150
# Males	143	1083	490	286	385	223	213	476	467	604
Total Shad	441	2,003	1,359	976	1,584	1,107	1,396	1,423	1,313	1,641
Liters of Eggs	101.8	309.6	222.6	137.5	246.0	249.0	294.7	213.5	205.5	299.0
Total # of Eggs	3,906,375	11,501,975	8,337,225	5,742,950	9,514,400	9,350,900	10,222,090	7,918,150	7,557,855	11,463,350
Total Fertile Eggs	1,687,629	5,898,446	3,260,799	3,268,708	4,466,611	3,207,860	3,508,795	3,921,239	4,554,483	7,882,600
# Re-stocked Fry							200,000	200,000	200,000	400,000

Table 4. Continued Summary of American Shad Collected from the Potomac River by MD DNR and Eggs Obtained

	2011	2012	2013	2014	2015	2016	Totals
# Ripe Females	304	1,828	1,168	579	569	947	9,975
# Green Females	355	1,744	1,199	1,065	1,482	907	9,752
# Spent Females	80	223	146	34	126	152	2,054
# Males	417	1,250	354	1,543	585	340	8,859
Total Shad	1,156	5,045	2,867	3,221	2,762	2,346	30,640
Liters of Eggs	168.5	619.5	441	180	174		3,862
Total # of Eggs	5,957,600	25,540,150	15,834,815	6,564,000	7,126,200		
Total Fertile Eggs	3,964,097	11,294,187	8,306,826	3,346,406	3,199,264		
# Re-stocked Fry	263,000	365,000	480,400	259,000	183,500	61,600	2,612,500

American Shad Age, Length, and Weight
Potomac River - 2016 (MD DNR)

Year Class	2007	2008	2009	2010	2011	2012	Total
Age	**9**	**8**	**7**	**6**	**5**	**4**	
Males							
Number			4	9	14	3	30
% by year class			13%	30%	47%	10%	100%
Av. TL (mm)			502	497	463	420	
Av. Wt. (kg)			1.01	0.98	0.84	0.64	
Females							
Number	1	4	7	59	18	1	90
% by year class	1%	4%	8%	66%	20%	1%	100%
Av. TL (mm)	535	535	523	502	477	455	
Av. Wt. (kg)	1.42	1.43	1.13	1.09	1.02	0.79	
Sexes Combined							
Number	1	5	11	68	32	4	120
% by year class	0.8%	4%	9%	57%	27%	3%	100%
Av. TL (mm)	535	535	516	501	470	429	
Av. Wt. (kg)	1.42	1.43	1.09	1.07	0.94	0.68	

American Shad Age, Length, and Weight
Potomac River - 2015 (MD DNR)

Year Class	2007	2008	2009	2010	2011	2012	Total
Age	**8**	**7**	**6**	**5**	**4**	**3**	
Males							
Number	4	9	30	28	8		79
% by year class	5%	11%	38%	35%	10%		100%
Av. TL (mm)	479	485	479	477	476		
Av. Wt. (kg)	1.19	1.13	1.13	1.12	1.13		
Females							
Number			7	22	11	2	42
% by year class			17%	52%	26%	5%	100%
Av. TL (mm)			515	507	494	447	
Av. Wt. (kg)			1.53	1.42	1.31	1.08	
Sexes Combined							
Number	4	9	37	50	19	2	121
% by year class	3%	7%	31%	41%	16%	2%	100%
Av. TL (mm)	479	485	486	490	487	447	
Av. Wt. (kg)	1.19	1.13	1.20	1.25	1.23	1.08	

American Shad Age, Length, and Weight
Potomac River - 2014 (MD DNR)

Year Class	2006	2007	2008	2009	Total
Age	**8**	**7**	**6**	**5**	
Males					
Number	3	14	32	12	61
% by year class	5%	23%	52%	20%	100%
Av. TL (mm)	502	477	471	477	
Av. Wt. (kg)	1.17	1.09	1.04	1.03	
Females					
Number	5	4	20	12	41
% by year class	12%	10%	49%	29%	100%
Av. TL (mm)	543	502	499	510	
Av. Wt. (kg)	1.48	1.07	1.16	1.25	
Sexes Combined					
Number	8	18	52	24	102
% by year class	8%	18%	51%	24%	100%
Av. TL (mm)	528	483	482	493	
Av. Wt. (kg)	1.36	1.08	1.08	1.14	

American Shad Age, Length, and Weight
Potomac River - 2013 (MD DNR)

Year Class	2006	2007	2008	2009	2010	Total
Age	**7**	**6**	**5**	**4**	**3**	
Males						
Number	0	8	17	22	1	48
% by Year class	0.00%	16.67%	35.42%	45.83%	2.08%	
Av.TL (mm)	0.00	488.75	476.94	475.05	469.00	
Av. Wt. (kg)	0.00	1.07	1.00	1.02	1.08	
Females						
Number	2	16	34	25	0	77
% by Year class	2.60%	20.78%	44.16%	32.47%	0.00%	
Av.TL (mm)	495.00	511.56	502.71	509.28	0	
Av. Wt. (kg)	1.12	1.29	1.22	1.27	0	
Sexes Combined						
Number	2	24	51	47	1	125
% by Year class	1.60%	19.20%	40.80%	37.60%	0.80%	
Av. TL (mm)	495.00	503.96	494.12	493.26	469.00	
Av. Wt. (kg)	1.12	1.22	1.14	1.15	1.08	

Table 5. Summary of American Shad collected and Eggs Produced by DDOE from the Potomac River

	2006	2007	2008	2009	2010	2012	2013	2014	2015	2016	Totals
# Ripe Females	19	148	65	151	158	177	203	103	71	244	1,339
# Green Females	8	348	80	158	170	337	189	160	115	213	1,778
# Spent Females	4	55	28	56	30	21	44	34	27	78	377
# Males	1	43	18	115	128	185	85	218	51	55	899
Total Shad	32	594	191	480	486	720	521	515	213	590	4,342
Liters of Eggs	4.3	64.8	34.8	81.0	87.5	102.2	94.5	42.8	0	33.0	544.8
Liters of Viable Eggs	3.4	46.2	14.8	41.1	60.3	64.9	59.8	27.4	0	0	317.9
Viable Eggs/Female	3,831	9,355	8,550	12,334	15,058	13,252	7,143	10,003	0	0	79,526
# Stocked Fry	114,920	963,600	461,710	1,122,650	2,072,411	1,920,612	1,216,443	796,787	0	0	8,669,133
in Anacostia River									Filtration system failure		

Source: DDOE

American Shad Age, Length, and Weight
Potomac River - 2015 (DDOE)

Year Class	2008	2009	2010	2011	2012	Total
Age	**7**	**6**	**5**	**4**	**3**	
Males						
Number	1	7	4	3	1	16
% by year class	6%	44%	25%	19%	6%	100%
Av. TL (mm)	473	485	480	467	430	
Av. Wt. (kg)	1.05	1.09	1.05	1.03	1.03	
Females						
Number	1	0	11	6	0	18
% by year class	6%	0%	61%	33%	0%	100%
Av. TL (mm)	495		492	499		
Av. Wt. (kg)	1.42		1.33	1.29		
Sexes Combined						
Number	2	7	15	9	1	34
% by year class	6%	21%	44%	26%	3%	100%
Av. TL (mm)	484	485	489	488	430	
Av. Wt. (kg)	1.24	1.09	1.25	1.20	1.03	

American Shad Age, Length, and Weight
Potomac River - 2016 (DDOE)

Year Class	2009	2010	2011	2012	2013	Total
Age	**7**	**6**	**5**	**4**	**3**	
Males						
Number	0	1	3	5	4	13
% by year class	0%	8%	23%	38%	31%	100%
Av. TL (mm)		495	493	481	428	
Av. Wt. (kg)		1.00	0.96	0.89	0.70	
Females						
Number	2	11	15	15	4	47
% by year class	4%	23%	32%	32%	9%	100%
Av. TL (mm)	528	511	488	482	461	
Av. Wt. (kg)	1.27	1.18	1.10	0.95	0.96	
Sexes Combined						
Number	2	12	18	20	8	60
% by year class	3%	20%	30%	33%	13%	100%
Av. TL (mm)	528	510	489	482	444	
Av. Wt. (kg)	1.27	1.17	1.08	0.94	0.83	

North Carolina American Shad Sustainable Fishery Plan

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EXECUTIVE SUMMARY

In accordance with the guidelines provided in Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring, North Carolina submits the following American Shad Sustainable Fishery Plan (SFP) for consideration by the Shad and River Herring Management Board (Board) to continue commercial and recreational fisheries in North Carolina. North Carolina's first Sustainable Fishery Plan for American Shad was approved by the Board in May 2012 for 2013 through 2017. The purpose of this plan is to update and modify sustainable management measures for 2018 through 2022 that will allow for maintenance and rebuilding of American Shad populations in North Carolina. The proposed plan includes the same sustainability parameters of relative fishing mortality (relative *F*) and abundance indices, but relative *F* will now be computed by dividing commercial landings by a hind cast 3-year average of a survey index whereas the previous plan used a centered 3-year average. Indices of relative abundance and estimates of relative *F* were calculated for each system using data from the previous plan, updated through 2017. Proposed thresholds (75^{th} and 25^{th} percentiles) for sustainability parameters have now been set using available survey data through 2017 and will remain fixed during the next 5-year management period. North Carolina requests recreational and commercial fisheries in all coastal rivers, and will use the management measures to ensure sustainability of these fisheries.

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1 INTRODUCTION

American Shad (*Alosa sapidissima*) are currently managed under Amendment 3 to the Atlantic States Marine Fisheries Commission (ASMFC) Interstate Fishery Management Plan for Shad and River Herring. The Amendment contains coastwide information on biology, stock status and management of American Shad and can be found on the ASMFC website at www.asmfc.org. Amendment 3 required states and jurisdictions to develop sustainable fishery plans (SFP) by January 2013, which were to be reviewed by the ASMFC Shad and River Herring Technical Committee and approved by their Board, in order to maintain commercial and recreational fisheries (with the exception of catch and release fisheries) for American Shad by (ASMFC 2010). A sustainable fishery is defined in Amendment 3 as "those that demonstrate their stock could support a commercial and/or recreational fishery that will not diminish future stock reproduction and recruitment". North Carolina's first SFP for American Shad was approved by the ASMFC Shad and River Herring Management Board in May 2012 for 2013 through 2017 (NCDMF and NCWRC 2012). The purpose of this plan is to update and modify sustainable management measures for 2018 through 2022 that will allow for the continued maintenance and rebuilding of American Shad populations in North Carolina.

The most recent stock assessment of American Shad stated that populations in the Albemarle Sound and Roanoke River are stable and low, whereas a determination of stock status could not definitively be assigned for the Tar-Pamlico, Neuse and Cape Fear rivers due to limited information (ASMFC 2007a). It should be noted that areas south of Albemarle Sound are in a zone where stocks transition from iteroparity (spawn multiple times over a lifetime) to semelparity (spawn only once followed by death), which can also impact the ability to determine stock status.

Sustainable fishery parameters are being submitted for consideration for the following areas: Albemarle Sound/Roanoke River, Tar-Pamlico River, Neuse River, and Cape Fear River.

2 REQUEST FOR FISHERIES

A sustainable fishery is defined in Amendment 3 as one that demonstrates shad stocks could support a commercial and/or recreational fishery that will not diminish future stock reproduction and recruitment. In the first American Shad SFP for North Carolina, a suite of potential sustainability parameters was considered, and it was decided to develop sustainability parameters for each river system based on relative abundance and relative fishing mortality rate (relative *F*). Relative abundance was calculated using available fisheries-independent survey data that were considered appropriate for measuring the abundance of American Shad and were expressed in terms of catch-per-unit-effort (CPUE). The standard deviations of the annual CPUE index values were also calculated to demonstrate the variability of these values. Environmental conditions on the spawning grounds, especially flow rates, are a major source of the variability associated with these indices. However, sample protocols accommodate variations in stream flow and fish distribution within the survey areas.

Relative *F* is calculated by dividing landings by a fisheries-independent index of relative abundance (Sinclair 1998). Imprecision in the survey index can cause estimates of relative *F* to be noisy. The noise can be dampened by using an average of the survey index over adjacent years in place of point estimates in the denominator. Herein, relative *F* was computed by dividing commercial landings by a hind cast 3-year average of a survey index. Note that in the previous SFP relative *F* was computed by using a centered 3-year average, resulting in the first and last year of

the time series based only on two years of data. The centered average was considered the best option to calculate relative *F* with the short time series of survey data available. However, with an additional five years of data the hind cast 3-year average is determined to be more appropriate, as it ensures the value of the final year in the time series (which can trigger management action) remains unchanged once calculated. In the Albemarle Sound/Roanoke River system, the survey data used in the calculations of relative *F* were subset to reflect the applicable season and gear restrictions for mesh size in the commercial fishery. For the other systems, it is not possible to subset the independent survey data to gear or months of the commercial fishery, due to available survey data for months and the electrofishing survey design. Therefore, relative *F* calculations for the Tar-Pamlico, Neuse, and Cape Fear River were subset to fishery-dependent commercial landings and fishery-independent survey data for March through April.

Indices of relative abundance and estimates of relative *F* were calculated for each system using data from the previous plan, updated through 2017. Thresholds (75^{th} and 25^{th} percentiles) for sustainability parameters will now be computed for set years in all systems. In the previous plan, thresholds were recalculated annually with the addition of another year of data, and there were concerns that the thresholds could slowly decline to extremely low levels without ever being exceeded. The thresholds for this plan will be fixed using the time series for the available survey data through 2017, for all surveys. Thresholds will be reevaluated during the next 5-year review of the plan.

The objective of this SFP update is to refine the calculations of the abundance indices and relative *F* estimates that currently serve as sustainability parameters in each system. Sustainability parameters are based on the female segment of the stock because the commercial fishery targets roe American Shad; roe landings can account for as much as 90% of the total American Shad landings in a year.

While scales have been collected for aging from both fisheries-dependent and fisheries-independent programs since 1972, there was concern regarding the reliability of scales for determining age for the following reasons: first, the scouring that allows for identification of spawning marks could result in loss of annuli and therefore inconsistent scale readings; and second, although increases in average age and percent of older individuals were observed, these were also associated with decreases in average length and weight. Because of these concerns and continued discrepancies between North Carolina Division of Marine Fisheries (DMF) and North Carolina Wildlife Resources Commission (WRC) in the determination of age and spawning marks, age data were not considered for sustainability parameters in any of the systems (See Appendix 1 of the 2012 SFP for additional detail).

The updated sustainability parameters are described below for each system and summarized in Table 1. The selected sustainability parameters will be reported in annual compliance reports and any management actions will be noted. Potential management actions are included in a separate section to eliminate repetition within each of the river system sections, although any action or suite of actions could be specific to and independent of each system.

2.1 Albemarle Sound/Roanoke River

Stock Status

The 2007 ASMFC stock assessment stated American Shad stocks in the Albemarle Sound and Roanoke River were low but stable and suggested a benchmark total mortality rate (Z_{30}) of 1.01

(ASMFC 2007b). Annual estimates of mortality (*Z*) from the assessment indicate that values have fluctuated around the benchmark since 2000.

Commercial Fisheries

The Albemarle Sound area has traditionally accounted for the largest proportion of the state's commercial harvest (Figure 2). Since 2001, American Shad landings from the Albemarle Sound area accounted for over 50% of the total American Shad harvest in North Carolina. Landings from gill nets comprised over 90% of the overall harvest across the same time period.

Recreational Fisheries

Recreational fisheries for Striped Bass (*Morone saxatilis*) and Hickory Shad (*Alosa mediocris*) have existed on the Roanoke River for many years, but little effort, catch or harvest of American Shad have been documented in annual creel surveys. However, creel surveys conducted by the WRC have traditionally focused on Striped Bass effort and harvest; therefore, estimates of American Shad harvest could be underestimated. The spring 2006 Roanoke River creel report estimated a directed harvest of 103 American Shad and release of 541 fish, but the harvest estimate was expanded from only seven observations (McCargo et al. 2007). Annual estimates of American Shad harvest have not been calculated for the Roanoke River fishery since 2006 when the ASMFC suspended the recreational harvest reporting requirements. Additionally, little to no focused recreational effort for American Shad occurs in the Albemarle Sound or tributaries, including the Roanoke River, as most effort is focused on Striped Bass. American Shad are most likely targeted by bank anglers in the Roanoke River, however anecdotal evidence from WRC biologists and enforcement officers indicates American Shad catch and harvest on the Roanoke River is minimal. WRC has not been able to expand the Roanoke River creel survey to include bank anglers due to limited staff availability and funding. The existing creel survey conducted by DMF in the Albemarle Sound and tributaries other than the Roanoke River also targets Striped Bass anglers, but recreational American Shad harvest is rarely documented. Despite the shortcomings of North Carolina creel surveys for estimating American Shad effort and harvest, directed recreational effort for American Shad is minimal because most recreational fisheries occur on the spawning grounds, most of which occur in Virginia portions of Chowan River tributaries. Recreational harvest from these tributaries, including Virginia portions of the Meherrin, Nottaway, and Blackwater rivers, that drain into the Chowan River is unknown. Through recent tagging data (see Section 5.1.2 for additional detail) we know that a large portion of American Shad are ascending the Chowan River, instead of the Roanoke River, to reach spawning grounds located in these Virginia systems. Additional cooperation between both Virginia and North Carolina is needed to properly evaluate the impact of the recreational fishery to the Chowan River spawning stock.

Sustainability Parameters

Data used in the development of sustainability parameters include independent gill net survey (IGNS) data collected by DMF, electrofishing data collected on the Roanoke River spawning grounds by WRC, and commercial landings data collected through the DMF Trip Ticket Program (see Section 5 for complete descriptions of these surveys).

A mortality benchmark of $Z = 1.01$ was calculated for the Albemarle Sound from the 2007 stock assessment, but there was concern that the total mortality estimate for a population in which the age distribution is contracting will not necessarily show an increase if there is no change in the slope that the *Z* estimate is based upon. As noted above, concerns regarding the reliability of scales for

determining age highly influenced the workgroup's decision not to use age data and the *Z* benchmark for sustainability parameters.

The following sustainability parameters and thresholds were evaluated for the Albemarle Sound area:

Female CPUE (electrofishing survey): The female CPUE index based on the WRC electrofishing survey was calculated as the number of fish per minute using data collected from March through May (Figure 3).

- Time series: 2001–2017.
- Threshold: Three consecutive years of values below the 25th percentile (where 75% of all values are greater) from the fixed time series 2001-2017.

Female CPUE (IGNS): The female CPUE index based on the DMF IGNS was calculated as the number of fish per haul using data collected during January through May (Figure 4).

- Time series: 2000–2017. Although the IGNS has been conducted since 1991, use of the 2000–2017 time series will allow for more consistent comparison with the female CPUE index from the Roanoke River electrofishing survey, which has been conducted annually since 2000.
- Threshold: Three consecutive years of values below the 25th percentile (where 75% of all values are greater) from the fixed time series 2001-2017.

Female Relative F (IGNS): Female relative *F* based on the DMF IGNS was calculated using commercial gill net landings of roe shad in Albemarle Sound (February through April, 2000-2013; March, 2014-2017) and a female index derived from data collected in the 5.0, 5.5 and 6.0-inch mesh sizes of the IGNS (February through April, 2000-2013; March, 2014-2017; Figure 5). The mesh sizes selected most accurately reflect those used by the commercial fleet. In the development of the 2012 SFP, the fishery independent index for the Albemarle Sound/Roanoke River was truncated to represent the commercial season, February through April. When the commercial season was reduced to March 3 through March 24, the IGNS was subset to the month of March for female relative *F* calculation from 2014 to 2017. This has increased the variability in the point estimates for relative *F* and reduced the sample size used in the IGNS index.

- Time series: 2002–2017. See description of time series for female CPUE based on the DMF IGNS.
- Threshold: Three consecutive years of values above the 75th percentile (where 25% of all values are greater) from the fixed time series 2002-2017.

The sustainability parameters selected for Albemarle Sound/Roanoke River were female CPUE based on the IGNS, female CPUE based on the electrofishing survey and female relative *F* based on the IGNS. Relative *F* based on the IGNS was chosen over relative *F* based on the electrofishing survey because the electrofishing survey is limited to the Roanoke River and so was not considered representative of Albemarle Sound as a whole. The commercial fishery only occurs in Albemarle Sound and its tributaries, except for the Roanoke River. From 1994 to 2017 only 68 pounds of American Shad were landed from the Roanoke River. The IGNS occurs in the same areas of the Albemarle Sound as the commercial fishery, so the calculation of relative *F* based on the IGNS rather than the electrofishing index was determined to be more appropriate. Exceeding the threshold for Female CPUE (IGNS) or Female Relative *F* (IGNS*)* will trigger management action.

Female CPUE (electrofishing survey) will be used in conjunction with a second index for triggering management action (see Section 3 for additional detail).

Results from recent telemetry studies indicate a substantial portion of American Shad tagged in the Albemarle Sound migrate up the Chowan River and into the Meherrin and Nottaway rivers, to date, there have been no tag detections in the Blackwater River. More research into the contribution from these systems is needed, but it appears the Chowan River tributaries are important spawning areas for American Shad entering the Albemarle Sound (See Section 5.1.2 for additional detail). Additionally, electrofishing surveys in the Meherrin, Blackwater and Nottaway rivers are conducted infrequently by the Virginia Department of Game and Inland Fisheries and cannot be used in the development of sustainability parameters.

The IGNS index of female relative abundance for Albemarle Sound has shown slight variation over time (Figure 4) and was below the threshold starting in 2011 for three consecutive years, triggering management action in 2014. The female abundance index derived from the electrofishing survey was above the threshold throughout most of the time series, except for 2006, 2010, and 2016 (Figure 3). This index demonstrated an increase from 2006 to 2008 but decreased in 2009 and dropped below the threshold in 2010. The index increased through 2014 to the highest value of the time series, before declining to below the threshold in 2016, and increasing again in 2017.

Estimates of female relative *F* derived from the IGNS also varied with time. The index exceeded the threshold in 2011 through 2014 and remained below the threshold for the past three years (Figure 5).

Additional Considerations

In 2005, state and federal fisheries management agencies in North Carolina and Virginia reached a Settlement Agreement with Dominion North Carolina Power regarding Federal Energy Regulatory Commission (FERC) relicensing of the Gaston and Roanoke Rapids lakes hydroelectric dams in the Roanoke River basin. Among the mitigation measures required by relicensing was a long-term, well-funded, and coordinated program to restore American Shad in the Roanoke basin. Measures outlined in this effort included improvements in hatchery production of fry, continued intensive monitoring of fry stocking success upstream and downstream of the mainstem reservoirs, development of techniques to estimate American Shad population size, and prescriptions for diadromous fish passage. This restoration effort is coordinated by the Diadromous Fish Restoration Technical Advisory Committee (DFRTAC), which includes representatives from U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), Virginia Department of Game and Inland Fisheries (VDGIF), WRC, DMF and Dominion Power. The license states that Dominion is required to design and implement upstream passage for American Shad when population estimates of 20,000 fish have been observed in two years. The target was developed based on a combination of 10% of the projected run size using the 50 shad per acre rule of thumb for riverine habitat between the dam and the river mouth (St. Pierre 1979) and very limited historic landings information. Multiple hydroacoustics research projects have attempted to estimate American Shad populations in the Roanoke River. The average run size estimate during 2006–2011 was 39,000 American Shad, suggesting the American Shad population had reached the target to begin fish passage efforts at Roanoke Rapids Dam (Hightower et al. 2013). Population estimation using the hydroacoustics techniques developed during this research is expensive and labor intensive; the estimates are also imprecise due to the uncertainty involved with assigning species to run count estimates and the difficulty conducting drift gill net studies in the lower Roanoke River. Additionally, evaluations of fry stockings upstream of dams indicate fish spawned upstream would

have little contribution to the population because of low downstream passage rates. Consequently, Dominion Power (with support of state and federal partners) has annually petitioned the FERC for a delay of the design of a fish passage program at Roanoke Rapids Dam. The DFRTAC continues to meet and evaluate the status of the Roanoke Rapids Dam FERC license agreement, including provisions for passage of American Shad.

The previous plan recommended development of creel survey methods to better estimate effort, catch, and harvest of American Shad in the Roanoke River. The existing creel survey conducted each spring on the Roanoke River targets Striped Bass effort and only estimates effort, catch, and harvest for anglers fishing from boats. Few American Shad are encountered each year during the existing Roanoke River creel survey. American Shad are most likely targeted by bank anglers; however, due to inadequate funding and staff availability, WRC has not been able to expand the Roanoke River creel survey to include bank anglers. Anecdotal evidence from WRC biologists and enforcement officers indicates American Shad catch and harvest on the Roanoke River is minimal.

Finally, DMF conducts an annual review of research priorities for all managed species. A top priority has consistently been expansion of existing surveys to meet the need for more accurate JAIs for species of importance. However, lack of funding and staff resources has delayed sufficient expansion of the alosine seine survey.

2.2 Tar-Pamlico River

Stock Status

Stock status could not be determined for the Tar-Pamlico River based on the 2007 ASFMC stock assessment (ASMFC 2007b). There were no definitive trends in abundance, although it was noted that the electrofishing CPUE for the Tar River was higher than in other North Carolina rivers since 2000. A Z_{30} of 1.01 is suggested (ASMFC 2007a).

Commercial Fisheries

Commercial landings of American Shad have declined significantly since the mid-1980s and have remained low and variable without trend since 1994 (Figure 2). Almost all harvest occurs in gill nets.

Recreational Fisheries

A recreational fishery does exist, and estimates of angler effort and catch are calculated using creel surveys. Previously, these surveys rotated among the Tar, Neuse, and Cape Fear rivers. Annual creel surveys coordinated between both DMF and WRC jurisdictions began in 2012 on the Tar-Pamlico and Neuse rivers, and on the Cape Fear River in 2013. Estimates of angler effort and catch are calculated through creel surveys noted in the fishery dependent section of this plan. A confounding factor in the creel survey is that anglers often indicate they targeted "shad" because American and Hickory Shad co-occur in the Tar-Pamlico River. The 2016 Tar-Pamlico creel survey determined recreational anglers caught 4,237 American Shad during 5,115 trips targeting American Shad, Hickory Shad, and non-specific shad species. Of the total catch, 1,417 American Shad were harvested (Table 2). The recreational daily creel limit is 10 American and Hickory Shad in the aggregate.

Sustainability Parameters

Data used in the development of sustainability parameters for the Tar-Pamlico system include electrofishing data collected by WRC and commercial landings data collected through the DMF

Trip Ticket Program (see Section 7 for complete descriptions of these surveys). There is no directed long-term JAI survey for the Tar-Pamlico system. An IGNS has been conducted consistently in the Tar-Pamlico, Pungo, and Neuse river tributaries of Pamlico Sound since 2004, but additional analysis is needed.

The following sustainability parameters and thresholds were evaluated for the Tar-Pamlico River system:

Female CPUE (electrofishing survey): The female CPUE index based on the WRC electrofishing survey was calculated as the number of fish per minute using data collected from March through May (Figure 6).

- Time series: 2000–2017. The electrofishing survey has been conducted annually since 2000 on the Tar River.
- Threshold: Three consecutive years of values below the 25th percentile (where 75% of all values are greater) from the fixed time series 2000-2017.

Female Relative F (electrofishing survey): Female relative *F* based on the WRC electrofishing survey was calculated using commercial landings of roes by all gear types from the Pamlico River and the female CPUE index from the Tar River electrofishing survey (Figure 7). Because the electrofishing survey primarily occurs during March through April, only commercial landings from those months were used in the calculations.

- Time series: 2002–2017. The electrofishing survey has been conducted on the Tar River annually during these years.
- Threshold: Three consecutive years of values above the 75th percentile (where 25% of all values are greater) from the fixed time series 2002-2017.

The sustainability parameters selected for the Tar-Pamlico River were the female CPUE index and female relative *F*, both derived from the WRC electrofishing survey. Exceeding the threshold for any of the selected parameters will trigger management action (see Section 3).

Female relative abundance of American Shad derived from the electrofishing survey in the Tar River has been relatively stable over the time series except for two notably high years in 2003 and 2004 (Figure 6). The index was below the threshold in 2006, 2007 and 2009 but above the threshold in all other years.

Estimates of relative *F* for female American Shad derived from the electrofishing survey were below the threshold during 2003 to 2006 (Figure 7). These estimates of female relative *F* exceeded the threshold in 2002, 2007, 2009, and 2012. The 2017 estimate is well below the threshold.

Additional Considerations

There is potential to improve upstream passage in this system. The WRC, USFWS, Pamlico-Tar River Foundation, and the Albemarle Pamlico National Estuary Partnership have engaged in conversations with the Rocky Mount Mills Dam owner and hydroelectric operator. In addition to interest in providing American Shad access to potential spawning habitat upstream of Rocky Mount Mills Dam, concern exists that hydropeaking operations (periodic spikes in flow) at Rocky Mount Mills Dam compromise the quality of existing spawning habitat. The dam owners agreed to cease hydropeaking during the anadromous spawning season, and the powerhouse has been out of operation for several years. The current owners of the dam have intentions to resume hydroelectric operation, and they are considering fish passage improvements as well.

A cooperative effort between DMF and WRC to improve the frequency and design of recreational creel surveys on the Tar-Pamlico and Neuse rivers began in spring 2012. Creel surveys have occurred annually since that time and include increased coverage on both rivers, which has improved estimates of recreational harvest.

As noted previously, DMF conducts an annual research prioritization exercise for all managed species. One of the top priorities has consistently been expansion of existing surveys to provide accurate juvenile abundance indices (JAI) for all commercially and recreationally important species. Meeting this priority is unlikely, due to the lack of funding available to the DMF to expand current monitoring programs.

2.3 Neuse River

Status of Stocks

Stock status could not be determined for the Neuse River based on the 2007 ASFMC stock assessment (ASMFC 2007b). There were no definitive trends in abundance over the most recent five to ten years of the assessment. A Z_{30} of 1.01 was suggested (ASMFC 2007a).

Commercial Fisheries

Commercial landings of American Shad have declined since 1972. There have been several peaks throughout the time series, but landings have remained low and variable without trend since the early 2000s (Figure 2). Harvest occurs almost entirely from gill nets.

Recreational Fisheries

Estimates of angler effort and catch are calculated through creel surveys noted for previous systems in the fishery-dependent section of this plan. The 2016 Neuse River creel survey determined total recreational catch to be 1,641 American Shad out of a total of 9,574 trips targeting American Shad, Hickory Shad, and non-specific shad species (Table 3). The majority of American Shad catch is released, as harvest was estimated to be only 252 American Shad in 2016. Additionally, as mentioned above a confounding factor in the creel survey is that anglers often indicate they targeted "shad" because American and Hickory Shad co-occur in the Neuse River system. A 1-fish daily limit on American Shad within the aggregate 10-fish recreational creel limit for American and Hickory Shad has been implemented in Coastal, Joint, and Inland Waters of the Neuse River.

Sustainability Parameters

Data used in the development of sustainability parameters for the Neuse River system include electrofishing data collected by WRC and commercial landings data collected through the DMF Trip Ticket Program (see Section 7 for complete descriptions of these surveys). There is no directed JAI survey for the Neuse River. As noted previously, there is an IGNS in the tributaries of Pamlico Sound. While the IGNS for the Neuse River area of the survey has been conducted since 2004, additional time is needed to properly evaluate this survey as an index for American Shad because effort is calculated differently than the Albemarle Sound IGNS. The following sustainability parameters and thresholds were evaluated for the Neuse River system:

Female CPUE (electrofishing survey): The female CPUE index based on the WRC electrofishing survey was calculated as the number of fish per minute using data collected from March through May (Figure 8).

- Time series: 2000–2017. The electrofishing survey has been conducted consistently since 2000 on the Neuse River.

- Threshold: Three consecutive years of values below the 25th percentile (where 75% of all values are greater) from a fixed time series of 2000-2017.

Female Relative F (electrofishing survey): Female relative *F* based on the WRC electrofishing survey was calculated using commercial landings of roes by all gear types from the Neuse River and the female CPUE index from the Neuse River electrofishing survey (Figure 9). Because the electrofishing survey primarily occurs during March through April, only commercial landings from those months were used in the calculations.

- Time series: 2002–2017. This time period reflects the years the electrofishing survey has been conducted on the Neuse River.
- Threshold: Three consecutive years of values above the 75th percentile (where 25% of all values are greater) from a fixed time series of 2002-2017.

The sustainability parameters selected for the Neuse River were the female CPUE index and female relative *F*, both derived from the WRC electrofishing survey. Exceeding the threshold for any of the selected parameters will trigger management action (see Section 3).

The electrofishing index of relative abundance for female American Shad in the Neuse River has been variable and remained above the threshold for the past seven years. The index was below the threshold in 2000, 2002, 2006, 2007, and 2010 (Figure 8). Relative *F* estimates for female shad derived from the electrofishing survey have been below the threshold since 2008 (Figure 9).

Future Considerations

Access to American Shad spawning habitat is affected by streamflow conditions on the Neuse River, and the variability in timing and strength of streamflow can determine where American Shad spawn. During high flow events, many American Shad migrate upstream to Milburnie Dam (rkm 352), which is the first mainstem dam on the Neuse River. Milburnie Dam is scheduled to be removed in 2017, and the removal will open approximately 25 km of additional spawning habitat to American Shad in the mainstem Neuse River. Future monitoring will determine if American Shad alter their migratory behavior in response to the dam removal. Additionally, further research is needed to determine how spawning success might be related to streamflow. The removal of Milburnie Dam, however, is expected to improve anadromous fish spawning habitat in the Neuse River, especially during high streamflow events.

As noted in the previous section, an annual creel survey rotation prior to 2012 as well as efforts by DMF to expand creel surveys upstream have improved recreational effort and catch/harvest estimates. Annual creel surveys in the Neuse River are anticipated to continue. Expansion of existing surveys to provide accurate JAIs for all commercially and recreationally important species is a DMF priority. Meeting this priority is unlikely, due to the lack of funding available to the DMF to expand current monitoring programs.

Similarly, a representative JAI for American Shad may be a future possibility depending on resources available to expand or reconfigure existing independent surveys.

2.4 Cape Fear River

Stock Status

Similar to the Tar-Pamlico and Neuse rivers, the stock status on the Cape Fear River is unknown, although a Z_{30} of 1.01 was recommended in the latest assessment (ASMFC 2007a, 2007b). Of all

the river systems in North Carolina, the Cape Fear is likely to have the highest proportion of fish that are semelparous (spawn once followed by death).

Commercial Fishery

Commercial landings have displayed several cyclical peaks since 1972, although each successive peak has been slightly lower than the previous. Landings were somewhat low throughout the 2000s (Figure 2). As with the other river systems, the vast majority of landings are from gill nets. There has been very little harvest from other gears.

Recreational Fishery

Like the other systems mentioned, a comprehensive creel survey was initiated in 2013 to identify and estimate recreational American and Hickory Shad effort and catch within the Cape Fear River system. In 2016, the estimate of total recreational catch was 21,011 American Shad from a total of 5,132 trips targeting American Shad, Hickory Shad, and non-specific shad species. Approximately 50% of the American Shad catch was harvested (Table 4). In 2013, the daily creel limit was reduced to a maximum of five American Shad within the 10-fish shad aggregate daily limit. It is important to note that Hickory Shad are encountered infrequently in the Cape Fear River and most of the recreational effort is focused on American Shad.

Sustainability Parameters

Data used in the development of sustainability parameters for the Cape Fear system include electrofishing data collected by WRC and commercial landings data collected through the DMF Trip Ticket Program (see Section 7 for complete descriptions of these surveys). There is no directed JAI survey for the Cape Fear River. While there was an IGNS from 2003–2007, it was a fixed- station survey rather than a stratified random design and was therefore not used in any sustainability parameter calculations.

The following sustainability parameters and thresholds were evaluated for the Cape Fear River system:

Female CPUE (electrofishing survey): The female CPUE index based on the WRC electrofishing survey was calculated as the number of fish per minute using data collected from March through May (Figure 10).

- Time series: 2001–2017. The electrofishing survey has been conducted annually since 2001 on the Cape Fear River.
- Threshold: Three consecutive years of values below the 25th percentile (where 75% of all values are greater) from the fixed time series 2001-2017.

Female Relative F (electrofishing survey): Female relative *F* based on the WRC electrofishing survey was calculated using commercial landings of roes by all gear types from the Cape Fear River and the female index from the Cape Fear River electrofishing survey (Figure 11). Because the electrofishing survey primarily occurs during March through April, only commercial landings from those months were used in the calculations.

- Time series: 2003–2017. This time period reflects the years the electrofishing survey has been conducted on the Cape Fear River.
- Threshold: Three consecutive years of values above the 75th percentile (where 25% of all values are greater) from the fixed time series 2003-2017.

The sustainability parameters selected for the Cape Fear River were the female CPUE index and female relative *F*, both derived from the WRC electrofishing survey. Exceeding the threshold for any of the selected parameters will trigger management action (see "Potential Management Measures").

Relative abundance of female American Shad from the electrofishing survey in the Cape Fear River was low from 2005 through 2011, and values were below the threshold from 2006 to 2011 (Figure 10). Since 2011, relative abundance of female American Shad has been above the threshold and continued to increase through 2015. Estimates of female relative *F* have remained below the threshold since 2012 (Figure 11).

Additional Considerations

Collaborative habitat enhancement projects that focus on fish passage and increasing spawning habitat have been implemented on the Cape Fear River in recent years. Each year, WRC recommends a locking schedule to the USACE to pass anadromous fishes upstream of locks and dams during the spring spawning run. In 2012, a rock arch fishway was constructed below Lock and Dam 1 (LD-1) to facilitate volitional, upstream fish passage. Telemetry studies conducted to evaluate American Shad usage of the rock arch fishway indicate American Shad passage efficiency at the LD-1 fishway ranged 53–65% and was consistent with prior estimates from locking procedures (Raabe et al. 2016). Electrofishing surveys corroborate the telemetry studies, as electrofishing catch rates have increased at the upper two locks and dams and decreased at LD-1 over the last five years. These results indicate American Shad are readily passing LD-1. With presumed historic spawning grounds, upstream of Lock and Dam 3 (LD-3), substrate was strategically placed below Lock and Dam 2 (LD-2) in 2013 to increase the potential spawning habitat for anadromous fish that pass the rock arch fishway but fail to navigate the lockage system. Locking at LD-1 has ceased at this point but continues for LD-2 and LD-3 to facilitate fish passage. American Shad spawning activity has been observed by Commission staff (Bennett Wynne, WRC retired, personal communication), and American Shad eggs have been collected just downstream of LD-2 (Dawn York, Cape Fear River Partnership, personal communication). Therefore, fish that migrated to LD-2 but failed to migrate farther upstream could reproduce and benefit from the habitat enhancement efforts. In recent years, 2016 and 2017, WRC staff have encountered eggs below LD-3 (Clinton Morgeson, WRC, personal communication). The Cape Fear River Partnership, including local, state, and federal agencies, as well as private groups, continues to plan fish passage enhancement projects on the remaining locks and dams on the main stem Cape Fear River.

Based on the construction efforts and changing conditions, DMF and WRC recommended a two-year review of the 75th percentile threshold for female relative *F* in the 2012 SFP as calculation of this parameter was likely to be heavily influenced by drought, floods, and changes in fish passage. There was also concern that restoration efforts might influence electrofishing catch rates due to improvements in fish passage with completion of the rock arch fishway. After review in 2015, no changes were recommended for the Cape Fear system. North Carolina will continue to evaluate American Shad relative abundance and sustainability metrics in the context of improvements in habitat and passage benefiting anadromous fishes in the Cape Fear River.

2.5 Pee-Dee River

The Pee-Dee River originates in North Carolina before flowing into South Carolina and emptying into Winyah Bay. Although approximately 25 km of American Shad spawning habitat is located in

the North Carolina portion of the Pee-Dee River, neither NCWRC nor NCDMF have the resources to conduct monitoring activities in this system. However, South Carolina Department of Natural Resources maintains dependent and independent survey programs in the South Carolina portion of the Pee-Dee River. Commercial and recreational fisheries were approved in the South Carolina SFP issued in 2012. Commercial harvest of American Shad is prohibited in the North Carolina portion of the Pee-Dee River, but recreational harvest is allowed under the statewide recreational creel limit of 10 American and Hickory Shad in combination per day. This recreational creel limit is consistent with the creel limit in South Carolina. We propose maintaining the recreational fishery in the North Carolina portion of the Pee Dee River and defer American Shad management and determination of sustainability to South Carolina. NCWRC will complement management actions in North Carolina waters to maintain consistency with South Carolina when appropriate.

2.6 Other Areas

The areas included in the sustainability parameters submitted for consideration above contain the known American Shad spawning populations in North Carolina, and those systems support the only directed recreational and commercial fisheries in the state. However, American Shad are incidentally encountered in commercial fisheries prosecuted within other non-spawning rivers and coastal sounds. Commercial harvest from these areas is a very small proportion of annual American Shad harvest (Figure 2) and is primarily considered incidental bycatch. For example, commercial harvest from the New and White Oak rivers (two coastal, blackwater rivers) combined averaged only 140 pounds per year between 1994 and 2016. Recreational effort and harvest in areas outside of spawning rivers is most likely non-existent. In the New and White Oak rivers, recreational creel survey intercepts from 2004 to present have not indicated American or Hickory Shad as target species and no American or Hickory Shad have been reported in the catch. While there are currently no independent surveys for American Shad outside of spawning rivers, surveys for other species rarely encounter American Shad. We propose to maintain current harvest seasons (February 15-April 14) to allow commercial harvest of incidental bycatch because these fish will most likely be dead discards and the amount of harvest is minimal. The areas without specified sustainability parameters will fall under default management measures listed in tables 8 and 9. North Carolina will continue to monitor commercial landings through the North Carolina Trip Ticket Program to ensure landings remain low. Dedicated monitoring programs or area closures will be implemented if sudden increases in landings, indicating targeted effort, occur.

3 MANAGEMENT MEASURES

3.1 Potential Management Measures

The environmental circumstances under which a sustainability threshold may be reached can vary among systems. Therefore, different management measures may be used for each system in addressing the triggers. One or more potential management measures presented here and may be used singly or in combination:

- Restrictions on length of season to reduce effort (e.g., March 1–April 14) not to extend beyond the estuarine striped bass quotas being filled (avoids waste of striped bass and shad)
- Trip limits (this may result in discards)
- Reduce allowable number of yards (the 1,000-yard limit in Albemarle Sound could be considered in other areas)
- Area/season closure (e.g., area closure at mouth of Roanoke River from February–mid-November since 1988)

- Only allow fishing certain days of the week (lift days)
- Recreational creel reduction
- Commercial harvest quota (although possible, this could be difficult to implement given existing resources)

If two years of sustainability parameters exceeding thresholds are observed, a suite of management measures could be proactively developed and presented to Finfish and Regional Advisory Committees.

3.2 Management Measures implemented 2013-2017

Changes in management (season lengths, creel limits) since implementation of the SFP in 2013 have been noted in Section 6 and are summarized for convenience in Tables 8 and 9.

Although harvest is an obvious potential contributor to population declines, significant habitat degradation has also occurred in all the river systems. It is unlikely that American Shad populations in North Carolina will recover and expand without considerable resources being dedicated to habitat restoration for this species. Our management goals, however, are intended to sustain population levels as additional habitat is protected or improved through aquatic habitat conservation measures and increased passage opportunities of American Shad beyond impediments that block migration to historic spawning grounds.

Cape Fear River

At the request of the ASMFC Shad and River Herring Technical Committee during development of the 2012 SFP, additional analysis was conducted for the Cape Fear River. This was based on the female relative *F* parameter being over the 75th percentile threshold for two consecutive years, as well as the female CPUE from the electrofishing survey being very close to the threshold for six consecutive years. An 11% percent reduction in commercial harvest was required to bring female relative *F* down to the threshold.

Additional analyses (see Appendix 2 of the 2012 SFP) were conducted to determine the commercial and recreational reductions in harvest that would provide an additional conservation buffer. It was determined that equivalent reductions in harvest for both commercial and recreational sectors would provide the greatest benefit given that commercial and recreational harvest in 2011 were roughly equivalent. Management options that resulted in a 25% reduction in harvest for each sector were calculated, and it was determined that a shortened commercial season and a reduction in the recreational creel limit would best meet the required reductions in harvest. While commercial and recreational harvests have fluctuated somewhat since regulatory changes were implemented, both the electrofishing index and relative *F* index have remained above and below their respective thresholds since 2012. A commercial season from February 20 through April 11 and a recreational creel limit of five fish within the 10-fish aggregate resulted in the necessary 25% reduction.

3.3 Proposed Management Measures for 2018

The following management measures are proposed to be effective January 1, 2018.

Recreational

Albemarle Sound/Roanoke River, Neuse River

- Recreational creel limit of 1-fish for American Shad in Joint and Coastal Waters to complement the WRC 1-fish limit in Inland Waters of these systems (no change to existing DMF and WRC rules).

Tar-Pamlico River

- Recreational creel limit of 10-fish for American Shad in the Joint, Coastal and Inland Waters (no change to existing DMF and WRC rules).

Cape Fear River

- Recreational creel limits of 5-fish for American Shad in the Joint and Coastal Waters of the Cape Fear River to complement the WRC 5-fish limit in the Inland Waters of this river (no change to existing DMF and WRC rules).

Commercial
Albemarle Sound

- Commercial season of March 3-24.

Tar-Pamlico River, Neuse River

- Commercial season of February 15-April 14.

Cape Fear River

- Commercial season of February 20-April 11.

While none of the selected sustainability parameters for any of the river systems have exceeded the triggers for management since 2013, the above measures are considered prudent given the results of the 2007 stock assessment as they pertain to North Carolina. Future changes to creel limits for American Shad in the Inland Waters of the other river systems will also be complemented by DMF for Joint and Coastal Waters.

4 ANCILLARY INFORMATION AND FUTURE CONSIDERATIONS

The focus on female indices for the sustainability parameters in all systems is based on the conclusion that changes in female abundance combined with impacts from various environmental parameters could prove challenging to stock improvement given that the commercial fishery targets roe shad. Major fluctuations in female abundance could potentially impact future recruitment and landings. The use of sex ratios as a sustainability parameter was considered, but it was determined that the sex ratios from both the IGNS (in the Albemarle system and potentially the other systems) and the electrofishing surveys were more suitable for use as long-term trends rather than short-term (i.e., three year) indicators of stock health due to the impact of environmental variability on the data. The intent of the agencies is to monitor the sex ratios from each of the surveys for trends and use this information to help inform future management.

An IGNS has been conducted consistently in the Tar-Pamlico, Pungo, and Neuse Rivers and tributaries of the Pamlico Sound since 2004. Unlike the Albemarle Sound IGNS, American Shad captured in this IGNS program do not have sex assigned in the program data for effort, if age structures are collected sex is assigned and reported in a separate aging program. Only a proportional estimate of sex can be applied to the small sample size. Additionally, effort is calculated differently, by gang of nets, compared to the Albemarle Sound IGNS which calculates effort per individual net. Additional analysis into the data caveats is needed to properly evaluate this survey as a new index of abundance for this plan.

The use of repeat spawning data was also considered as a potential sustainability parameter. However, inconsistencies in determination of repeat spawning marks made it difficult to set a target or threshold. Because repeat spawning continues to be tracked annually as part of the required monitoring program, it will also be used as ancillary information for determining future management. Should greater confidence in repeat spawning data be attained in the future, they may be considered for developing a formal sustainability parameter.

Sustainability parameters have been updated annually in compliance reports, as well as via annual appendices to the SFP detailing changes in management measures. DMF and WRC also jointly review the performance of the plan on an annual basis to determine management measures for the following season.

Finally, during the preparation of this update, both DMF and WRC discussed exploring several additional sustainability parameters, as well as potential future modifications to existing sustainability parameters:

- Consider alternate means of calculating effort from the IGNS and possible incorporation of IGNS from Tar-Pamlico and Neuse as parameters;
- Consider incorporating uncertainty in relative *F* estimates;
- Consider use of alternative modeling approaches that can incorporate environmental parameters as model factors;
- Consider alternative ways to calculate relative *F* including using recreational catch estimates and total catch from the IGNS.

If appropriate, North Carolina would submit a revised SFP for Technical Committee review to allow for inclusions or modifications described above.

5 STOCK MONITORING PROGRAMS

The following descriptions represent the entirety of stock monitoring programs used to assess the health of American Shad in North Carolina. All programs are included in annual compliance reports and as noted in the program descriptions, specific details can be found in past compliance reports.

5.1 Fishery-Independent Monitoring

5.1.1 Juvenile Abundance

A juvenile abundance index is calculated for Albemarle Sound area using data from the alosine seine survey that has been conducted annually since 1972. Eleven core seine stations are sampled monthly in the western Albemarle Sound area during June–October of each year. During September, thirteen additional seine samples are taken to determine distribution and annual variations of alosines in the nursery area. All stations are sampled with an 18.5-m (60-ft) bag seine. Relative abundance data are collected for Blueback Herring, Alewife, American Shad and Hickory Shad from the 11 core stations.

Samples are sorted by species and 30 randomly selected individuals of each alosine species present are measured. Other species present are also noted. Water temperature, salinity, and other environmental characteristics are counted, measured, and recorded. As noted previously, this survey was designed specifically for blueback herring and is not considered a reliable indicator of juvenile American Shad abundance.

No juvenile abundance indices exist for the Tar-Pamlico, Neuse and Cape Fear River systems.

5.1.2 Adult Stock Monitoring

Spawning Area Survey

An annual spawning stock survey and representative sampling for biological data is required from Albemarle Sound and its tributaries, Tar-Pamlico, Neuse, and Cape Fear Rivers for American Shad. Sampling in these areas was initiated in 2000.

WRC personnel collect American Shad from the Roanoke, Tar, Neuse and Cape Fear systems annually during February–June. A boat-mounted electrofishing unit (Smith-Root 7.5 GPP) is used (1 or 2 dip netters) to capture fish during daylight hours, and electrofishing times are recorded in seconds. To minimize size selection during sampling in all river systems, shad are netted as they are encountered regardless of size. Relative abundance of each year-class is indexed by CPUE expressed as the number of fish captured per hour of electrofishing. However, CPUE is converted to fish per minute for sustainability indices described above. American Shad broodstock collections are usually excluded from calculations of CPUE unless collections occur during regular sampling activities. Because broodstock are sacrificed when hatchery spawning is complete, otoliths from broodstock are aged and used to develop age length keys in most years. Total length (mm), weight (g), and sex are recorded for all captured fish. Sampling protocols are unique to each river system and have been refined throughout the survey period. River-specific descriptions of spawning area surveys are provided in the following sections.

Roanoke River

American Shad surveys have been conducted in the Roanoke River from 2001 through 2017. The surveys occur in the mainstem Roanoke River near the Gaston Boating Access Area at river kilometer (rkm) 225. The survey area encompasses the most upstream American Shad spawning habitat in the Roanoke River, and further migration beyond the survey area is blocked by Roanoke Rapids Dam at rkm 227 (approximately 2 km upstream of the survey area). In 2000–2007, sampling was concurrent with Striped Bass surveys in the same sample area and was restricted to April and May. Beginning in 2008, sampling was started earlier in March when water temperatures approach 10^{o}C and continued weekly until low-flow conditions restrict boat navigation or until spawning appears complete (typically end of May or first of June). One dip netter was used 2000–2004 and 2010–2011, whereas two dip netters were used 2005–2009 and 2012–2017. Also in earlier years (2000–2012), two or three shoreline sample sites approximately 1 km each were sampled per week. In 2013–2017, however, samples were conducted at nine sampling sites once per week during the survey period. Electrofishing commenced at the upstream portion of each 500-m site and continued downstream the entire transect. Sites were randomly selected from shoreline and mid-channel habitats along the 3-km stretch downstream of the Hwy 48 bridge. Total electrofishing effort increased from previous years, but the new sample protocol still occurs in the same area as previous years.

Tar River

American Shad spawning area surveys have been conducted on the mainstem Tar River from 2000 through 2017, and survey protocols have changed relatively little throughout the survey period. One dip netter is used to capture fish during daylight hours. Electrofishing samples are conducted weekly during March–May. Sampling begins when water temperatures approach 10^{o}C. Sample sites are located within one of three approximately 15-km segments that encompass most of the American Shad spawning habitat in the Tar River. Segment 1 contains the river stretch from Rocky Mount Mill Dam downstream to the Dunbar Boating Access Area (BAA). Segment 2 includes the

river stretch from Dunbar BAA downstream to the Bell's Bridge BAA. Segment 3 continues from the Bell's Bridge BAA downstream to the Tarboro town ramp. Normally, one sample of approximately 30 minutes of electrofishing time is conducted within a segment during a sample day. Typically, only one 30-minute sample is conducted per week, yet, depending on flows, attempts are made to conduct another 30-minute sample in a different segment, or at least in a different site of the same segment, during that same week. Sample sites within a segment vary from week to week and are selected from areas that appear to have preferred American Shad habitat. Angling activity is avoided. Flows and water temperature determine which segment is sampled on a particular day. Moderate to high flows and warmer water temperatures tend to cause American Shad to move further upstream into segment 1. There are certain minimum river levels required to allow access to the river for electrofishing, yet the majority of American Shad sampling is concentrated in segment 1 when flows are greater than 300 cfs. Flooding often prevents access to the river for sampling, but high water subsides quickly in the Tar River and at least one sample site per week is usually possible.

Neuse River

American Shad electrofishing surveys have been conducted in the Neuse River from 2000 through 2017 and one dip netter is used to capture fish during daylight hours. Electrofishing samples are conducted weekly during March–May. Sampling begins when water temperatures approach 10^{o}C and ends when spawning appears to be complete. Sampling is conducted near known spawning areas at Goldsboro, NC (rkm 240) and Raleigh, NC (rkm 350). Sampling begins at the downstream Goldsboro location in March, and the Raleigh location is added to the weekly sampling regime once 30–40 American Shad are collected in one day at the Goldsboro location. Weekly sampling locations are contingent upon water levels because low flows limit navigability. The Raleigh location is only accessible at moderate to high flows and is dropped from weekly sampling when flows are not adequate for safe and effective sampling. When conditions improve, sampling is resumed at the Raleigh location. Sampling locations have been consistent throughout the survey period, but sampling protocols at each location have varied over time. In early years of the survey, two sample sites were sampled at each location. The sample sites were 2–3 km long and took over one hour of electrofishing time to complete. Since 2015, two or three sample sites are sampled at each location, but the sites have been shortened to around 1 km and electrofishing effort has been reduced. Nevertheless, the same areas have been consistently sampled throughout the survey.

Cape Fear River

Sampling for American Shad has occurred in the Cape Fear River from 2001 through 2017. In most years, one dip netter was used to collect American Shad, but two dip netters have been used 2015–2017 to avoid gear saturation caused by increases in American Shad abundance. In all survey years, sampling occurred at three fixed sample sites adjacent to the base of each of three locks and dams found on the river. Since 2010, sampling efforts have been standardized by electrofishing for 30 minutes downstream of each lock and dam—15 minutes from the middle of each dam down each shoreline. Sampling at each site is attempted weekly when water temperatures approach 10^{o}C and is ended when spawning appears complete. Prior to 2010, however, sampling was more sporadic and did not always occur at each site every week. Other areas in the Cape Fear River upstream of the locks and dams (Buckhorn Dam and Smiley's Falls) are also sampled, but data from sites other than the locks and dams are not included in annual relative abundance analyses. Sampling at the locks and dams is possible under most flow conditions, but flood events can periodically prevent sampling.

Independent Gill Net Survey (IGNS)

Since 1991, DMF has been conducting an independent gill net survey throughout the Albemarle Sound area. The survey was designed for Striped Bass data collection and occurs November through May each year. However, American Shad are captured during the survey and size, age and sex data are collected. Forty-yard segments of gill net from 2.5- through 7.0-inch stretched mesh, in half-inch increments, as well as 8.0, and 10.0-inch stretched mesh are utilized. The sound is divided into zones and grids and random sites are selected within these areas. Lines of float and sink nets are set in both shallow and deep strata if they are present in the grid.

The IGNS in the Pamlico Sound area began 2001, while the rivers (including Pamlico, Pungo and Neuse rivers) began in 2003. The Cape Fear River was added in 2007 and the Core Sound area will begin fully in 2018. The survey runs from February through mid-December and utilizes a different methodology than that conducted in the Albemarle Sound. Thirty-yard segments of gill net are used, ranging from 3.0-inch stretched mesh through 6.5-inch stretched mesh in half-inch increments. The catch from the gang of nets comprises a single sample, unlike the Albemarle where each mesh net is tallied for effort. Each gang of nets is fished in both shallow and deep strata, and sites are preselected at random from within strata-grids.

Albemarle Sound American Shad Movement Study

The Roanoke River and Chowan River tributaries are known spawning rivers for American Shad entering Albemarle Sound. Despite the restoration efforts and research that has occurred in the Roanoke River, the proportion of American Shad migrating up the Chowan River or Roanoke River is largely uncertain. The NMFS and DMF have been conducting an acoustic telemetry study to determine migratory patterns of Albemarle Sound American Shad. The objective of this study was to determine which river basins are used by adult American Shad during the spawning run in 2013, 2014, 2016, and 2017. The study used an existing array of acoustic receivers placed at inlets and throughout Albemarle Sound and the Roanoke River. DMF, WRC, and NCSU maintain and operate these receivers to track movement of Atlantic Sturgeon, Striped Bass, and Largemouth Bass. The study area encompassed the Albemarle Sound, and its associated sounds (Croatan and Currituck) and rivers: North, Pasquotank, Little, Perquimans, Chowan, Roanoke, Scuppernong, and Alligator in northeastern North Carolina and the Meherrin, Nottaway, and Blackwater in southeastern Virginia. Adult American Shad were captured in gill nets with mesh sizes ranging from 4.5 to 6 inches at locations north and south of North Carolina Highway 32 bridge. This area is a funneling point for American Shad that have entered the Albemarle sound to reach spawning grounds on either the Chowan River (north) or the Roanoke River (south). American Shad were implanted with VEMCO V9-2x-A69-1601 coded acoustic transmitter and a PIT tag (only in 2013). Tagged fish were measured and assigned sex if possible. Fish were tagged by inserting the tag through the esophagus into the stomach. Fin clips were taken in 2016 and 2017 to determine hatchery contribution from Roanoke River stocked fish. The acoustic transmitter released a frequency every 90 seconds and tag life was expected to be around two years.

Since 2013, a total of 191 American Shad have been tagged. Table 7 shows the numbers of fish tagged, detected, and that made spawning runs up the Roanoke or Chowan Rivers. The fish that were detected but did not make spawning runs either demonstrated strong fall back behavior and presumably left the sound or are thought to have died.

Shad movement data gathered by this study suggest that a large portion of the spawning stock entering the Albemarle Sound is ascending the Chowan River to spawn. Future studies are needed to

determine potential genetic differences between Chowan River and Roanoke River spawning stocks. Any genetic differentiation between the two rivers can be used to further evaluate spawning stock contribution within the Albemarle Sound population and can allow for more refined management and restoration efforts. Fin clips have been collected from the commercial fishery for future genetic analysis.

5.1.3 Size, Age and Sex Determination

Spawning Area Survey

Sex is determined for each captured fish by applying directional pressure to the abdomen toward the vent and observing the presence of milt or eggs. Each fish is measured for total length in millimeters. Scales are removed from the left side of each fish between the lateral line and the dorsal fin. To estimate age, scales are examined at 33X magnification on a microfiche reader and annuli are counted. Spawning marks are recorded separately. Shad that cannot be aged are assigned ages based on the gender specific age-length key developed for each river and included in CPUE and size-distribution analyses. Beginning in 2011, American Shad have been aged using otoliths, or age distributions have been calculated by applying age-length keys from years when otolith ages were aged up to 10 fish per 10-mm size bin (by sex) are sacrificed for otolith extraction. Broodfish were used to develop age-length keys in addition to spawning area survey fish.

Independent Gill Net Survey

Each fish is measured for fork length and total length. Sex is always determined for fish captured in the Albemarle Sound IGNS. Each fish is sexed by applying directional pressure to the abdomen toward the vent and observing the presence of milt or eggs. Scales are collected from the left side of each fish between the lateral line and the dorsal fin. Scales are prepared and aged according to the Cating (1953) method.

5.1.4 Total Mortality Estimates

Survival estimates are calculated using the Robson and Chapman (1961) method. Robson and Chapman showed that estimates of annual rates of survival can be made from the catch curve of a single season if the population is exposed to unbiased fishing gear beyond the age of recruitment and if year-class strength and survival rate remain constant from year to year. Annual mortality rates are calculated based on observed samples of individuals at age. Only age groups that are fully recruited to the gear are included in the calculations and the resulting estimates only apply to the fully recruited individuals.

5.2 Hatchery Evaluation

5.2.1 Roanoke River American Shad Restoration Project

Since 1998, over 72 million American Shad fry have been stocked in the Roanoke River downstream of Kerr (US Army Corps of Engineers), Gaston (Dominion Power) and Roanoke Rapids (Dominion Power) reservoirs at Weldon, NC. Since 2003, American Shad fry have also been stocked upstream of Kerr Reservoirs at Altavista, Clover Landing, VA; in Gaston Reservoir at Bracey, VA; and Roanoke Rapids Lake near Roanoke Rapids, NC (Table 5). These stocking activities serve as migratory obstruction mitigation required by Federal Energy Regulatory Commission (FERC) relicensing of the Gaston and Roanoke Rapids hydropower dams. The stockings upstream of dams are experimental to evaluate escapement of American Shad and determine the benefits of future fish passage efforts.

In the early years of the restoration project, WRC followed protocols of other states involved in American Shad restoration efforts and obtained broodfish for fry production from nearby rivers having adequate shad stocks. American Shad broodfish were collected by electrofishing from the Tar, Neuse, Cape Fear, and Roanoke rivers from 1998–2010. Hormone injection was used to initiate spawning in the hatchery from 1998 to 2008, but in 2009, for the first time, broodfish were not injected with hormone (LHRHa or sGnRHa pellets) upon arrival at the hatcheries and prior to being transferred to circular spawning tanks. In 2011, only broodfish collected from the Roanoke River were utilized for production. Upon collection, broodfish are placed in circular tanks with oxygen and continuously circulating water onboard the electrofishing boats and are then transferred to large circular, trailer-mounted tanks for transport to the hatcheries.

Annual contribution of hatchery-origin American Shad to the Roanoke River population is evaluated for multiple cohorts of returning adults during the spring spawning run and for out-migrating juveniles during fall of the stocking year. Evaluation of hatchery contribution to the Roanoke River American Shad population was conducted using oxytetracycline (OTC) marks from 1998–2009. Subsequent testing proved OTC marking procedures and analyses were unreliable, and the WRC initiated use of genetic microsatellite markers for parentage-based tagging (PBT) methods in 2010. With the PBT method, each spawning tank contains a genetically discrete batch of broodfish, from which the progeny can be uniquely identified. Fin clips from all American Shad broodfish were stored in numbered vials containing non-denatured, spectrophotometric grade ethanol to later be referenced for determining hatchery origin of at-large fish produced in a given year. All PBT analyses were conducted by the genetics laboratory at the North Carolina Museum of Natural Sciences (NCMNS). Daily OTC marking techniques have not been used since the switch was made to PBT analysis. Fin clips from adult American Shad are collected during spawning stock surveys, and broodfish are also cross-referenced for potential hatchery contribution of stockings from previous years. Broodfish fin clips combined with fin clips collected during weekly samples are collectively referred to as at-large adults

Parentage-based-tagging efforts were initiated in 2010, and the early results (i.e., 2010–2014) cannot capture potential hatchery contribution from year classes before 2010. Thus, percent contribution of hatchery fish is underestimated and should be considered a minimum prior to 2015. Hatchery contribution from these early years should not be used to make inferences regarding the overall hatchery contribution of the spawning stock but can be used to assess hatchery contribution for specific year classes.

In 2012, a total of 289 fin clips was assessed using PBT techniques. Only one fish was determined to be of hatchery origin and was matched with broodfish from the 2010-year class. In 2013, a total of 26 out of 527 at-large adults was found to be of hatchery origin; 25 were matched to the 2010-year class and one to the 2011-year class. In 2014, a total of 708 fin clips was processed, and 90 were determined to be of hatchery origin (12.7%). Of the total, 54 were matched with broodfish from the 2010-year class, 34 from the 2011-year class, and 2 from the 2012-year class. In 2015, 233 of 543 processed fin clips were found to be of hatchery origin (42.9%); 66 were matched with the 2010-year class, 141 with the 2011-year class, 23 with the 2012-year class, and 3 with the 2013-year class. In 2016, 522 fin clips were processed, and 293 were determined to be of hatchery origin (56.1%); 33 were matched with broodfish from 2010, 191 matched with the 2011 broodfish, 38 matched with the 2012 broodfish, and 31 matched with the 2013 broodfish. Between 2010 and 2014, all hatchery-origin fish were stocked at Weldon (below Roanoke Rapids Dam). In 2016, one of the hatchery identified fish was stocked into the Staunton River, upstream of Kerr Reservoir.

This is the first conclusive evidence of a fish being stocked above Kerr Reservoir being captured as an adult on the spawning grounds.

In 2016, a sample of fin clips was obtained from shad intercepted in the Albemarle Sound. A total of 4 out of 117 (3.4%) Albemarle Sound fish was determined to be of hatchery origin; the hatchery fish were from the 2011 and 2012 year classes. In 2017, 5 of 126 (4.0%) fin clips from Albemarle Sound American Shad were determined to be stocked fish. The 2011, 2012 and 2013 year classes were represented in the 2017 stocked fish. In both years, the hatchery contribution in the Albemarle Sound sample was lower when compared with hatchery contribution on the spawning grounds, indicating that Roanoke River spawning fish do not make up the majority of the Albemarle stock. Subsequent years of sampling will continue to investigate this relationship by obtaining fin clips from the Chowan River (when possible), Roanoke River, and Albemarle Sound.

Out-migrating juvenile American Shad are typically collected at night in the lower Roanoke River near Plymouth, NC from September to November using boat-mounted electrofishing gear. Since 2010, hatchery contribution of the out-migration has been assessed using PBT methods and has ranged from 2.7% (2012) to 44.8% (2014); average hatchery contribution was 21% over the survey period. To identify bottlenecks in passage in the Roanoke River, genetically distinct batches of fry were systematically stocked in the Staunton River upstream of Kerr Reservoir, Gaston Reservoir, Roanoke Rapids Lake, and Weldon. Hatchery fish identified in the out-migration can be conclusively matched to their stocking location; from 2010 through 2015 only hatchery-origin juveniles stocked at Weldon were collected. In 2016, however, six hatchery origin juveniles from the out-migrating sample were determined to be stocked in Roanoke Rapids Lake. Results from experimental fry stockings suggest fry spawned upstream of the reservoirs would contribute to the out-migrating juvenile population at a much lower rate than fry spawned downstream of the reservoirs. Thus, it may not be prudent to pass spawning adults upstream of the reservoirs until methods to improve downstream passage are developed.

5.2.2 Neuse River American Shad Restoration Project

The WRC began an American Shad restoration stocking program in the Neuse River in 2012. The goal of the Neuse River American Shad stocking program is to supplement the wild population by stocking fry produced from one spawning tank of approximately 100 broodfish each year. American Shad broodfish are collected from the Neuse River near Goldsboro, NC and are transported to Edenton National Fish Hatchery where they can spawn and fry are reared for approximately 7 days. American Shad fry are stocked in the Neuse River near Goldsboro, NC. Evaluation of hatchery contribution to the Neuse River American Shad population is conducted using the same PBT methods as described for the Roanoke River restoration program. A total of 4,893,186 American Shad fry have been stocked in the Neuse River at the NC Hwy 117 bridge near Goldsboro, NC since 2012, and hatchery contribution to out-migrating juvenile samples has been low (0–13%;Table 6). Hatchery contribution to returning adults has also been low. In 2016, which was the first-year hatchery fish were potentially available as age-4 adults, only 9 of 411 (4%) adults tested with PBT analysis were of hatchery-origin. Contribution of stocked fish may increase slightly in the future as more hatchery cohorts will move into the spawning population, but it appears the stocking program is contributing very little to the overall American Shad population in the Neuse River.

5.3 FISHERY-DEPENDENT MONITORING

5.3.1 Commercial Fishery

Total Catch, Landings and Effort

American Shad landings data are collected through the North Carolina Trip Ticket Program. The number of participants by gear utilized and the total number of positive trips can be determined. For the Albemarle Sound area, the following assumptions are made: (1) trips landing over 100 pounds of shad are considered directed trips, and (2) the maximum yardage used in directed trips is 1,000 yards. The total yardage for each area is determined by multiplying the number of participants by the maximum yardage per area. The catch-per-yard (CPY) is determined by dividing the number of pounds harvested by the total yardage estimate of gill nets fished and multiplied by 1,000 yards. This will result in the pounds landed per 1,000 yards. Catch estimates for other areas are determined similarly.

Size, Age and Sex Composition of Catch

Commercial landings from all four systems (Albemarle Sound, Tar-Pamlico River, Neuse River and Cape Fear River) are sampled to obtain size, age, sex and repeat spawning information. A target of 200 samples from each system has been in place since 1999. For specific information regarding exact number of samples collected per area, please see previous compliance reports.

5.3.2 Recreational Fishery

Total Catch, Landings and Effort

The North Carolina Fisheries Reform Act of 1997 required the MFC to establish limits on recreational use of commercial fishing gear. An individual holding a Recreational Commercial Gear License (RCGL) can use limited amounts of specified commercial gear to catch seafood for personal consumption or recreational purposes. The holder of the RCGL must comply with the recreational size and creel limits, and RCGL catch cannot be sold. During 2002, DMF began a RCGL survey to estimate the harvest by these license holders. The survey was discontinued in 2009 due to budget reductions.

An annual creel survey occurs on the Roanoke River each year. The survey targets Striped Bass catch and effort but also collects information on American Shad and other species, although American Shad catch is low due to the fishing method.

5.3.2.1 Central Southern Management Area Catch, Landings, and Effort

A rotating creel survey occurred on the Tar, Neuse and Cape Fear rivers prior to 2012. A comprehensive creel survey was initiated in 2012 to identify and estimate recreational American and Hickory Shad effort and catch within these systems, which are collectively known as the Central Southern Management Area (CSMA). The CSMA was originally established for purposes of estuarine striped bass management and includes all Internal Coastal, Joint, and contiguous Inland waters of North Carolina south of a line from Roanoke Marshes Point across to Eagle Nest Bay to the South Carolina state line. The areas surveyed in the CSMA include the Neuse, Trent, Tar/Pamlico, Cape Fear and Pungo rivers. The Neuse River basin drains over 6,200 square miles of land with over 3,000 miles of streams and rivers. The mouth of the main channel is six miles across – the widest in the United States. Over 1.3 million residents reside within this river basin. Major tributaries include Crabtree, Swift, and Contentnea creeks, along with the Eno, Little, and Trent rivers. Survey points included 45 boat ramps and fishing access points from Millburnie Park in East Raleigh to Lee's Landing on Broad Creek. The river was divided in three segments, with all

access points in Goldsboro and above classified as the upper zone, sites on Contentnea Creek and downstream from Goldsboro to Core Creek were considered the middle zone, and those downstream from Core Creek, the lower zone. Prior to 2012, the Neuse River was comprised of only two zones with all sites above Contentnea Creek considered the upper.

The Tar/Pamlico River watershed drains over 5,500 square miles with over 2,400 miles of streams and rivers. Major tributaries include Cokey Swamp, Swift, Fishing, and Tranters creeks, and the 30-mile Pungo River near Belhaven, North Carolina – the main tributary in the lower basin. Access points surveyed on the Tar/Pamlico River include 19 boat ramps and access sites from Battle Park in Rocky Mount to the Quarterdeck Marina in Bath, NC. This system was divided into upper and lower zones, with sites upstream of Greenville, North Carolina considered the upper zone. The Pungo River was surveyed at the Leechville ramp (NC-264 bridge), the Belhaven WRC ramp, Wrights Creek WRC ramp, and Cee Bee Marina on Pungo Creek.

The Cape Fear River is the southernmost river within the CSMA and was included to target shad (American and hickory) beginning in 2013.

5.3.2.1.1 Sampling Procedures

Recreational fishing statistics from the CSMA were calculated through a non-uniform stratified access-point creel survey (Pollock et al. 1994). Site probabilities were set in proportion to the likely use of the site according to time of day, day of the week, and season. Probabilities for this survey were assigned based on observed effort from past years and direct observation by creel clerks. Morning and afternoon periods were assigned unequal probabilities of conducting interviews, with each period representing half a fishing day. A fishing day was defined as the period from one hour after sunrise until one hour after sunset. Monthly sampling periods for each river and zone were stratified accordingly, and all weekend and holiday dates along with two randomly selected weekdays were chosen from each week for sampling.

Tar/Pamlico River anglers in the upper zone were interviewed throughout the spring months (January-May), while anglers in the lower zone were interviewed year-round based on the evidence of a year-round fishery and no seasonal closures. Two creel clerks were assigned to this river, with one surveying the upper zone January through May and one clerk surveying the lower zone from January through December. The three zones within the Neuse River were covered with one creel clerk per zone. The lower zone was surveyed from January to December while middle zone surveys were conducted January-May and the upper zone surveys from February-May. The Pungo River was surveyed throughout the year with one creel clerk.

Returning fishing parties were interviewed by a creel clerk at the selected access point to obtain information regarding party size, effort, total number of fish harvested and/or released, primary fishing method, and location. Harvested fish were identified, counted, measured nearest mm fork length (converted to centerline length and total length for appropriate species), and weighed to the nearest 0.1 kg, while information on discarded fish was obtained from the angler to acquire the number and status of discarded individuals. The age structures were given to the Fisheries Management section of DMF for age determination. Creel clerks also obtained socioeconomic information from the angler, including age, state and county of residence, sex, ethnic background, marital status, number of individuals within household, and trip information and expenditures

5.3.2.1.2 Analysis

Effort and Catch Estimations

Samples were reduced to shad species effort and catch only. Results were stratified by river, access point, and time of day. Catch was defined as the sum of harvested fish and discarded fish. Discarded fish equaled the sum of fish caught in excess of creel limits (over-creel), legal-sized fish caught and released, and sub-legal fish returned to the water. Daily effort and catch for each river were calculated by expanding observed numbers by the sample unit probability (time of day probability divided by access area probability). Total catch estimates for the CSMA and catch estimates for each zone and type of day were calculated based on the Horvitz-Thompson estimator for non-uniform probability sampling as such:

$$C = \sum_{i=1}^{n} (c_i / p_i)$$

where a sample of number (n) units is taken, and the probability of the *i*th unit being in the sample is denoted by P_i (Pollock et al. 1994). Total effort over the CSMA and each individual zone and type of day were estimated in the same fashion, as were other extrapolated data. Approximate standard errors (SE) of the catch and effort estimates within zone and type of day were calculated according to:

$$SE = \sqrt{N^2 \left(\frac{s^2}{n} \right)}$$

where s^2 is the variance of the observations, n is the number of days sampled, and N is the number of days of that type available for sampling (Pollock et al. 1994). Estimated catch per unit effort (CPUE) values were obtained by dividing estimated catch by estimated shad spp. trips as well as angler hours (angler-h) in order to identify trends in fishing pressure and angler success. Size structure of shad spp. in harvests was described for each zone using length-frequency distributions of observed samples. Fishing party characteristics and methods used during shad spp. trips reported by anglers were documented by river and day type. The database was created using Access© and statistical analyses were performed with SAS 9.1©. Beginning in 2012, the Wildlife Resources Commission (WRC) Portal Access To Wildlife Systems (PAWS) was used to house these data and estimate effort and catch. DMF and WRC staff have been verifying calculations to ensure consistency with the previous work.

Angler Demographics and Economic Analysis

The CSMA Creel Survey socioeconomic questionnaire included questions to identify characteristics of the shad spp. angling population. Demographics of anglers were reported according to age, residency, gender, ethnic background, marital status, and expressed as a percentage of the total angling population throughout the CSMA. Mean values were calculated. Results were further grouped by river and day type. Anglers were considered to be local, regional, or out-of-state residents. Local anglers resided within the county, while regional anglers resided elsewhere in North Carolina. The socioeconomic questionnaire also included questions regarding trip length, distance traveled, party size, and expenses on lodging, food, ice, bait, equipment rental, and boat fuel and oil. Mean weighted expenditures per trip were reported by river and day type. Lodging and rental expenses were rarely encountered and therefore are not included within this report. The weighted mean of each expenditure was totaled to provide an average trip cost.

For specific information regarding catch and harvest of American Shad, please see previous compliance reports.

5.4 Bycatch and Discards

Bycatch and discard information are not currently collected on commercial trip tickets. The only mechanism that exists to capture commercial bycatch and discards of American Shad in other fisheries is an observer program conducted by DMF to monitor sea turtle and sturgeon interactions in gill nets, as required under the Incidental Take Permits (ITP) for both. The state-wide sea turtle ITP was approved first in September 2013 followed by the Atlantic Surgeon ITP in July 2014. Prior to the approval of the Sturgeon ITP there was little observer coverage in the Western Albemarle Sound and the rivers when the directed American Shad fishing season occurs because there are very few encounters with sea turtles in these areas during that time of year. Observer coverage has increased in recent years, under the Sturgeon ITP because there have been encounters with sturgeon in these areas and times of year where directed American Shad fishing occurs. Even though observer coverage in the area have increased, gear, area, and seasonal restrictions are thought to have kept shad discards relatively low.

Recreational creel surveys capture discard and release information of American Shad and non-target species, but hook-and-line discard mortality is not estimated. Please see previous compliance reports for this information.

6 FISHERY MANAGEMENT PROGRAM

American Shad are jointly managed by the North Carolina Marine Fisheries Commission (MFC) and the North Carolina Wildlife Resources Commission (WRC). The Division of Marine Fisheries (DMF) implements MFC rules for American Shad in the Atlantic Ocean as well as the Coastal and Joint waters of North Carolina, while the WRC Inland Fisheries Division manages American Shad in the state's recreational fishery in Inland Waters. The known extent of American Shad in North Carolina river systems is shown in Figure 1. This Plan is developed by the American Shad Working Group (ASWG) which consists of biologists from both DMF and WRC. The ASWG meets annually to review sustainability parameters and develop associated actions for the management of American Shad in North Carolina's Inland, Joint, and Coastal waters.

6.1 Commercial Seasonal Restrictions (statewide)

From the 1950s to 1965, a January 1 through May 1 commercial season existed in Coastal Waters, while a January 1 through June 1 season existed in Inland Waters throughout the state. From 1966 through 1994, no seasonal restrictions existed for the commercial fishery. Since 1995, a commercial season of January 1 through April 14 has been in place in Coastal and Joint waters although the fishery is rarely opened prior to February 1 each year. Implementation of this seasonal restriction reduced harvest, as a large portion of the commercial American Shad harvest historically occurred after April 14 and into May.

In 2013, under the first year of the North Carolina American Shad SFP, the commercial seasons were restricted to February 15 through April 14 in all systems except for the Cape Fear River (Table 8). In the Cape Fear River, the commercial season was restricted to February 20 through April 11. Following the 2013 season, thresholds in the Albemarle Sound/Roanoke River system were exceeded for three consecutive years (2011,2012, and 2013) triggering further management action; as a result, the commercial season was reduced to March 3 through March 24 to constrain harvest. This season has remained in place for the Albemarle Sound/Roanoke River system since 2013.

6.2 Commercial Gear Restrictions

Albemarle Sound/Roanoke River

Beginning in 1987, western Albemarle Sound (also referred to as Batchelor Bay) has been closed to the use of gill nets from February through mid-November. While the purpose of the closure is Striped Bass conservation, this measure has also afforded protection for American Shad. From 1988 through 1990, limits of 1,000 to 2,000 yards were implemented for 5.25-inch stretched mesh and larger gill nets in Albemarle Sound, and nets could only be set 5 days per week. In April 2016, the MFC adopted a permanent rule implementing yardage restriction for nets with a mesh length of 4.0-inch stretched mesh or greater, the maximum length of gill net shall not exceed 2,000 yards per vessel in all Internal Coastal Waters regardless of the number of individuals involved.

Since 1998, commercial restrictions in Albemarle Sound have been consistent and include a prohibition on the use of gill nets with a mesh size of 3.5–5.0 inches stretched mesh and a limit of 1,000 yards on the use of 5.25-inch and greater (floating) stretched mesh during the open shad season. When the season closes, these nets are removed from the water. The Albemarle Sound is the only system for which mesh size restrictions and yardage limits exist during the shad season.

The Roanoke River has been closed to the use of anchored gill nets since 1991 and drift gill nets since 1993 which greatly reduced harvest of American Shad.

Tar-Pamlico River, Neuse River

Since 2016 a statewide rule limits the amount of large mesh (4.0-inch and greater) gill net set in internal Coastal waters to no more than 2,000 yards per vessel. Prior to 2016 a former rule was suspended in the majority of internal Coastal waters as a result of sea turtle conservation measures to institute no more than 2,000 yards per vessel of 4.0–6.5-inch gill net in the Tar-Pamlico and Neuse systems. Additionally, in certain sections of the Tar-Pamlico and Neuse rivers, gill nets with a mesh size less than five inches must be attended at all times.

Also, it is unlawful to use gill nets of any mesh size in Joint Fishing Waters from midnight on Friday to midnight on Sunday each week (except for portions of Albemarle and Currituck sounds). These existing gill net measures have likely reduced American Shad harvest since they have remained in effect since the spring 2012 fishing season and will remain in effect indefinitely.

Cape Fear River

There are different gill net restrictions then described above for the Tar-Pamlico and Neuse systems (i.e. mesh lengths, spacing, set/retrieval days and times) for the Cape Fear system. Nets can be set in lengths no greater than 100 yards and must have at least a 25-yard space between each individual length of net. Only single overnight sets are allowed; nets can be set one hour prior to sunset and must be retrieved within one hour of sunrise, with no sets allowed Friday, Saturday or Sunday evenings, and the maximum yardage allowed is a 1,000-yard limit per vessel.

It is unlawful to use gill nets of any mesh size on weekends in the Cape Fear system. This measure will remain in effect indefinitely.

6.3 Recreational Restrictions

Prior to 1995, no recreational restrictions existed. Beginning in 1995, it became unlawful to take American Shad and Hickory Shad by any method except hook-and-line from April 15– December 31 in Coastal Waters. Additionally, from 1995 through 1998, there was a recreational season

during January 1 through April 14. Beginning in 1999, it became unlawful to possess more than 10 American Shad and Hickory Shad in the aggregate in both Coastal and Inland Waters.

In 2013, under the first year of the North Carolina American Shad SFP, a 1-fish American Shad limit within the 10-fish aggregate creel limit was implemented in the Joint and Coastal waters of both the Albemarle Sound/Roanoke River and the Neuse River to complement the existing 1-fish limits implemented by the WRC in the Inland Waters of those systems (Table 9). In the Cape Fear system, both the WRC and DMF implemented a 5-fish American Shad limit within the aggregate 10-fish creel limit in their respective jurisdictional waters to meet the requested Technical Committee reductions. All recreational limits have remained unchanged since 2013. The changes noted here have been implemented via rule in Inland Waters by the WRC and via proclamation in Coastal and Joint Waters by DMF.

Albemarle Sound/Roanoke River

In 2010, the WRC implemented a 1-fish American Shad limit within the 10-fish aggregate creel limit for American and Hickory Shad in the Inland Waters of the Roanoke River. DMF complemented the 1-fish limit in Joint and Coastal Waters in 2013. Due to the size of the Albemarle Sound there is no recreational effort for American Shad in the sound itself, and little to no effort is concentrated in the tributaries of the Albemarle Sound. Recreational effort mainly occurs in the Roanoke River where the focus of angler effort is on Striped Bass and American Shad catch is primarily incidental. In Virginia, the Meherrin, Nottaway, and Blackwater Rivers drain into the Chowan River, which a substantial portion of the spawning stock entering the Albemarle Sound ascend to spawn at the head waters of these rivers. Recreational effort in these Virginia systems is not taken into consideration under this plan. While the impact of recreational harvest in Virginia waters is unknown to the spawning stock entering the Albemarle Sound, it is important to note the creel limit in these rivers remains a 10-fish aggregate for American and Hickory Shad.

Neuse River

A WRC rule implementing a 1-fish limit for American Shad in the Inland Waters of the Neuse River became effective in August 2012. DMF complemented the 1-fish limit in Joint and Coastal Waters in 2013.

Tar-Pamlico River

The 10 American and Hickory Shad aggregate creel limit applies throughout the waters of the Tar-Pamlico River and its tributaries.

Cape Fear River

In November 2013, the WRC implemented a 5-fish limit for American Shad within the 10-fish aggregate creel limit in the Inland Waters of the Cape Fear River. DMF complemented the 5-fish limit in Coastal and Joint Waters in 2013.

Atlantic Ocean

Possession of American Shad is prohibited.

All other internal waters

Recreational harvest of American Shad is very rare in internal waters other than those described above. Current regulations, however, allow for a daily harvest of up to 10 American and Hickory Shad, in the aggregate. This regulation includes North Carolina portions of the Pee Dee River.

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7 TABLES

Table 1. North Carolina Sustainable Fishery Plan for American Shad summary of management thresholds and triggers for 2018-2022.

System	Index	Threshold Value	Time Series	Threshold Level	Management Trigger
Albemarle/ Roanoke	Roanoke River Female CPUE	0.131	2001-2017	25th percentile	3 consecutive years below the threshold; does not trigger management by itself
Albemarle/ Roanoke	Albemarle Sound Female CPUE	0.0277	2000-2017	25th percentile	3 consecutive years below the threshold
Albemarle/ Roanoke	Female Relative *F*	1,740,876	2002-2017	75th percentile	3 consecutive years above the threshold
Tar/Pamlico River	Female CPUE	0.384	2000-2017	25th percentile	3 consecutive years below the threshold
Tar/Pamlico River	Female Relative *F*	20,243	2002-2017	75th percentile	3 consecutive years above the threshold
Neuse River	Female CPUE	0.1275	2000-2017	25th percentile	3 consecutive years below the threshold
Neuse River	Female Relative *F*	198,625	2002-2017	75th percentile	3 consecutive years above the threshold
Cape Fear River	Female CPUE	0.112	2001-2017	25th percentile	3 consecutive years below the threshold
Cape Fear River	Female Relative *F*	186,354	2003-2017	75th percentile	3 consecutive years above the threshold

Table 2. Tar-Pamlico River recreational creel survey estimates for trips targeting Shad species (including hickory and American Shad) in numbers and pounds of fish, 2012-2016.

		Effort				Catch					
		Trips (#)	PSE	Hours	PSE	Harvest (#)	PSE	Pounds (lb)	PSE	Discard (#)	PSE
American	2012	490	37.2	1,399	47.6	899	41.9	1,711	41.9	4,257	33.5
	2013	106	78.4	125	85.1	2,484	23.6	6,841	24.1	7,057	41.4
	2014	20	100.0	3	100.0	162	66.6	0	0.0	1,302	74.6
	2015	54	100.0	54	100.0	1,006	47.7	3,262	47.7	2,784	78.7
	2016	1,347	31.1	5,806	51.4	1,417	37.2	807	0.0	2,820	34.0
Hickory	2012	321	47.0	486	46.6	403	61.0	0	0.0	7,286	38.0
	2013	0	0.0	0	0.0	2,250	58.2	2,970	58.3	5,490	55.3
	2014	190	66.2	248	73.1	341	70.1	0	0.0	2,052	56.6
	2015	107	73.7	398	75.3	864	64.4	1,009	65.1	3,848	57.9
	2016	295	52.5	2,086	68.9	1,409	70.9	0	0.0	11,590	67.2
Shad Species	2012	321	47.0	486	46.6	403	61.0	0	0.0	7,286	38.0
	2013	7,314	17.9	16,455	19.9	234	100.0	0	0.0	6,079	34.0
	2014	2,420	22.9	5,701	35.5	0	0.0	0	0.0	17	100.0
	2015	3,521	24.9	9,200	34.5	0	0.0	0	0.0	2,105	88.2
	2016	3,473	27.1	10,160	38.9	0	0.0	0	0.0	0	0.0

Table 3. Neuse River recreational creel survey estimates for trips targeting Shad species (including hickory and American Shad) in numbers and pounds of fish, 2012-2016.

		Effort				Catch					
		Trips (#)	PSE	Hours	PSE	Harvest (#)	PSE	Pounds (lb)	PSE	Discard (#)	PSE
American	2012	8,268	34.7	17,528	29.0	354	104.2	2,141	38.2	511	47.0
	2013	395	28.4	869	27.2	1,384	47.2	3,197	48.7	2,699	62.2
	2014	426	70.1	1,181	82.1	416	51.3	0	0.0	964	61.4
	2015	344	42.5	1,135	43.4	94	76.1	0	0.0	132	46.3
	2016	451	56.2	1,481	35.1	252	47.3	0	0.0	1,389	60.6
Hickory	2012	11,659	28.3	23,157	26.1	10,672	27.4	11,998	28.5	29,041	39.8
	2013	570	39.8	1,517	43.4	12,810	28.4	13,030	26.2	14,138	29.6
	2014	181	65.6	886	60.7	14,557	44.3	16,492	47.0	27,100	39.4
	2015	300	50.7	1,259	48.8	10,418	28.5	10,213	31.5	12,186	42.6
	2016	225	68.7	415	78.4	10,851	36.6	11,140	36.4	29,276	58.0
Shad Species	2012	11,659	28.3	23,157	26.1	10,672	27.4	11,998	28.5	29,041	39.8
	2013	14,840	14.9	31,249	19.1	0	0.0	0	0.0	765	57.7
	2014	12,779	22.0	30,532	30.5	0	0.0	0	0.0	136	100.0
	2015	6,775	21.2	15,393	30.2	0	0.0	0	0.0	136	75.3
	2016	8,898	18.3	25,741	28.1	0	0.0	0	0.0	899	61.8

Table 4. Cape Fear River recreational creel survey estimates for trips targeting Shad species (including hickory and American Shad) in numbers and pounds of fish, 2013-2016.

		Effort				Catch					
		Trips (#)	PSE	Hours	PSE	Harvest (#)	PSE	Pounds (lb)	PSE	Discard (#)	PSE
American	2013	0	0.0	0	0.0	20,243	21.1	46,522	21.0	6,438	73.7
	2014	114	84.5	188	88.0	7,234	25.3	23,027	25.6	0	0.0
	2015	0	0.0	0	0.0	4,136	32.7	11,502	32.2	6,125	39.3
	2016	4,550	15.0	18,820	22.5	10,265	22.1	28,427	22.8	10,746	28.6
Hickory	2013	0	0.0	0	0.0	13	0.0	0	0.0	135	100.0
	2014	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	2015	0	0.0	0	0.0	12	100.0	0	0.0	0	0.0
	2016	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Shad Species	2013	12,334	22.3	54,807	22.1	2,050	44.8	4,029	44.8	26,457	38.5
	2014	2,820	17.9	11,762	22.2	174	84.0	0	0.0	10,300	56.4
	2015	3,414	22.2	13,933	26.3	0	0.0	0	0.0	264	71.7
	2016	582	60.7	3,681	72.0	0	0.0	0	0.0	648	79.7

Table 5. American Shad fry stocked into the Roanoke River Basin from 1998–2016. Stockings downstream of the lower-most dam occur at Weldon, NC, stockings upstream of John H. Kerr Dam occur at either Altavista or Clover Landing, VA, stockings upstream of Gaston Dam occur at Bracey, VA, and stockings upstream of Roanoke Rapids Dam occur at Roanoke Rapids, NC. Hatchery evaluation techniques have transitioned from Oxytetracyclene (OTC) marks to parentage-based tagging methods using genetic microsatellite markers.

Year	Total Fry Stocked (millions)	Fry Totals (millions) by Stocking Location					Hatchery Evaluation Technique	Age Class at-large
		Weldon, NC	Altavista, VA	Clover Landing, VA	Bracey, VA	Roanoke Rapids, NC		
1998	0.5	0.5	-	-	-	-	OTC	18
1999	0.3	0.3	-	-	-	-	OTC	17
2000	0.8	0.8	-	-	-	-	OTC	16
2001	2.1	2.1	-	-	-	-	OTC	15
2002	0.8	0.8	-	-	-	-	OTC	14
2003	2.3	1.2	1.1	-	-	-	OTC	13
2004	2.3	1.2	1.1	-	-	-	OTC	12
2005	2.5	1.3	1.2	-	-	-	OTC	11
2006	2.4	1.4	1.0	-	-	-	OTC	10
2007	4.3	2.2	2.1	-	-	-	OTC	9
2008	8.2	4.3	3.9	-	-	-	OTC	8
2009	8.6	4.5	4.1	-	-	-	OTC	7
2010	7.8	6.9	0.9	-	-	-	OTC/PBT	6
2011	4.4	4.0	-	0.4	-	-	OTC/PBT	5
2012	4.8	3.8	-	1.0	-	-	OTC/PBT	4
2013	4.5	2.4	-	1.3	0.8	-	PBT	3
2014	7.5	3.5	-	1.4	2.6	-	PBT	2
2015	4.8	2.6	-	0.8	1.5	-	PBT	1
2016	3.8	1.3	-	-	-	2.5	PBT	0
Total	72.7	45.1	15.4	4.9	4.9	2.5		

Table 6. American Shad fry stocked into the Neuse River Basin at NC Highway 117 bridge near Goldsboro and juvenile hatchery contribution based on parentage-based tagging analysis, 2012–2016.

Year	Fry Stocked	Out-migrating Juvenile Hatchery Contribution
2012	573,582	2%
2013	1,184,303	6%
2014	1,377,375	13%
2015	708,045	1%
2016	609,720	0%*
2017	440,161	NA
Total	4,893,196	

*Sample size was only 7 fish

Table 7. American Shad movement study results in numbers of fish tagged in the Albemarle Sound and numbers of tagged fish detected on spawning runs in the Roanoke and Chowan River from 2013-2017.

			Spawning Run	
Year	Tagged	Detected	Roanoke	Chowan
2013	7	5		1
2014	53	35	2	8
2016	56	29		2
2017	75	58	2	22

Table 8. Commercial harvest seasons for American Shad 2012-2017.

System	**2012***	**2013**	**2014**	**2015**	**2016**	**2017**
Albemarle Sound Roanoke River	2/1 - 4/14	2/15 - 4/14	3/3 - 3/24	3/3 - 3/24	3/3 - 3/24	3/3 - 3/24
Tar-Pamlico	2/1 - 4/14	2/1 - 4/14	2/1 - 4/14	2/1 - 4/14	2/1 - 4/14	2/1 - 4/14
Neuse	2/1 - 4/14	2/1 - 4/14	2/1 - 4/14	2/1 - 4/14	2/1 - 4/14	2/1 - 4/14
Cape Fear	2/1 - 4/14	2/20 - 4/14	2/20 - 4/14	2/20 - 4/14	2/20 - 4/14	2/20 - 4/14
All Other Areas	2/1 – 4/14	2/15 – 4/14	2/15 – 4/14	2/15 – 4/14	2/15 – 4/14	2/1 – 4/14

*last year prior to SFP implementation

Table 9. Recreational creel restrictions for American Shad 2012-2017. All numbers represent limits within an overall 10-fish aggregate creel limit for American and Hickory Shad combined.

System	2012*	2013	2014	2015	2016	2017
Albemarle Sound Roanoke River	1-fish IW 10-fish CJW*	1-fish	1-fish	1-fish	1-fish	1-fish
Tar-Pamlico	10-fish	10-fish	10-fish	10-fish	10-fish	10-fish
Neuse	1-fish IW 10-fish CJW*	1-fish	1-fish	1-fish	1-fish	1-fish
Cape Fear	10-fish	5-fish	5-fish	5-fish	5-fish	5-fish
All Other Areas	10-fish	10-fish	10-fish	10-fish	10-fish	10-fish

*last year prior to SFP implementation; IW=Inland Waters; CJW = Coastal and Joint Waters, blank=all waters

8 FIGURES

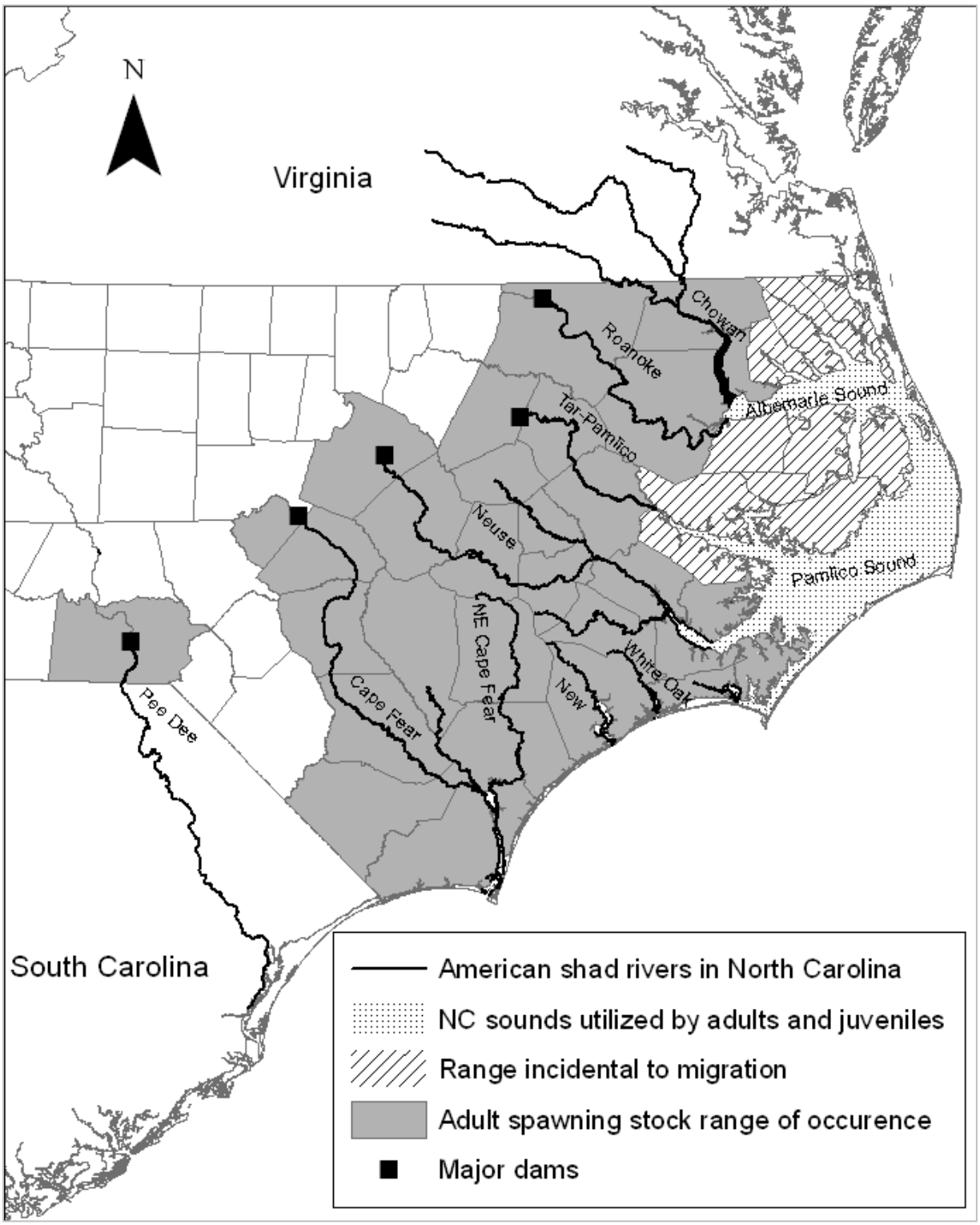


Figure 1. North Carolina river systems depicting the extent of American Shad occurrence and habitat use.

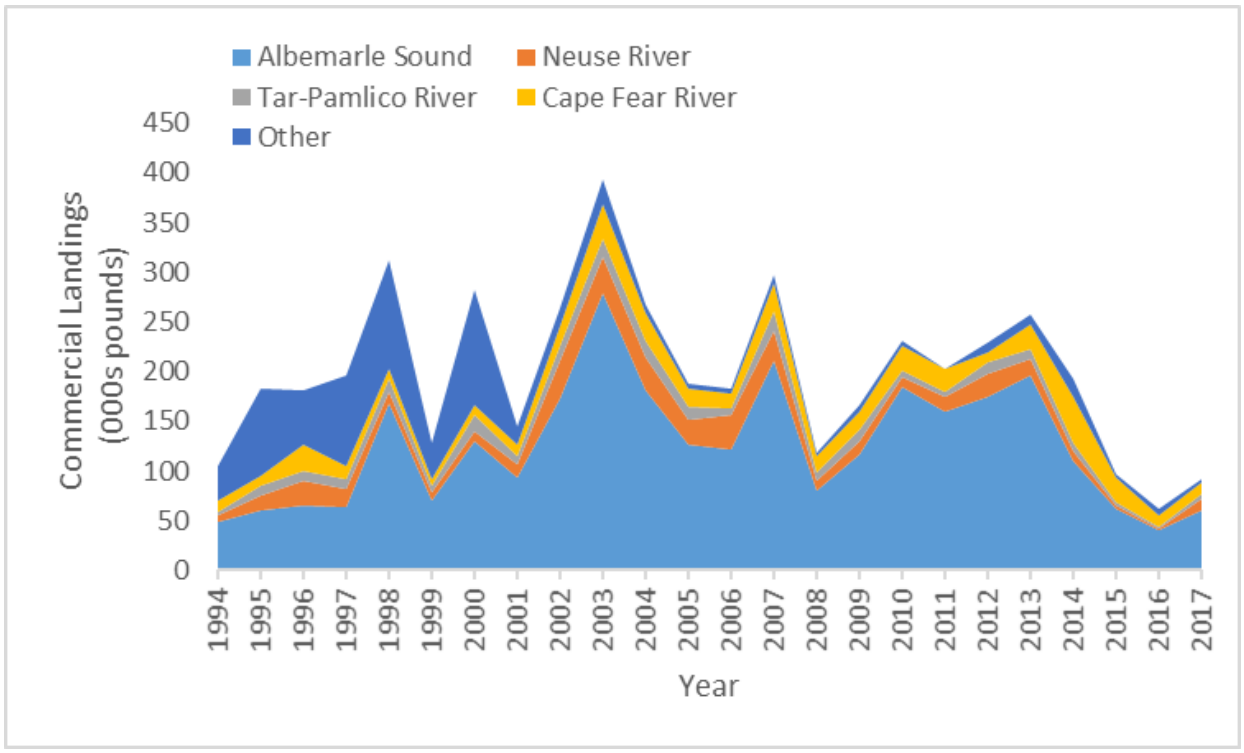


Figure 2. Commercial landings of American Shad in North Carolina by water body, 1994–2017.

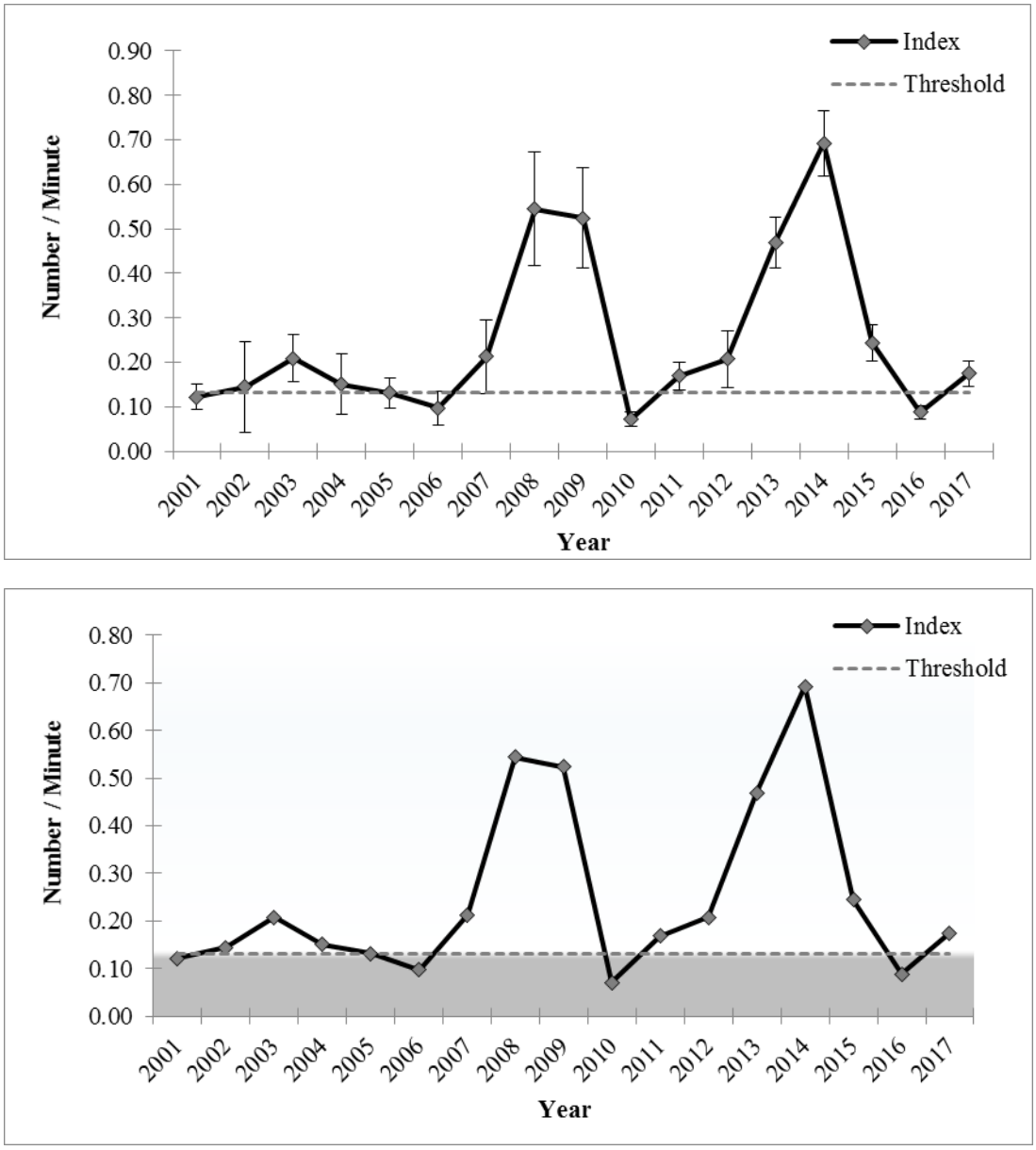


Figure 3. Female index from electrofishing survey (March–May) for Roanoke River, 2001-2017. Threshold represents 25th percentile (where 75% of all values are greater). Error bars represent ±1 standard deviation (top graph). Values in gray are below the threshold (bottom graph).

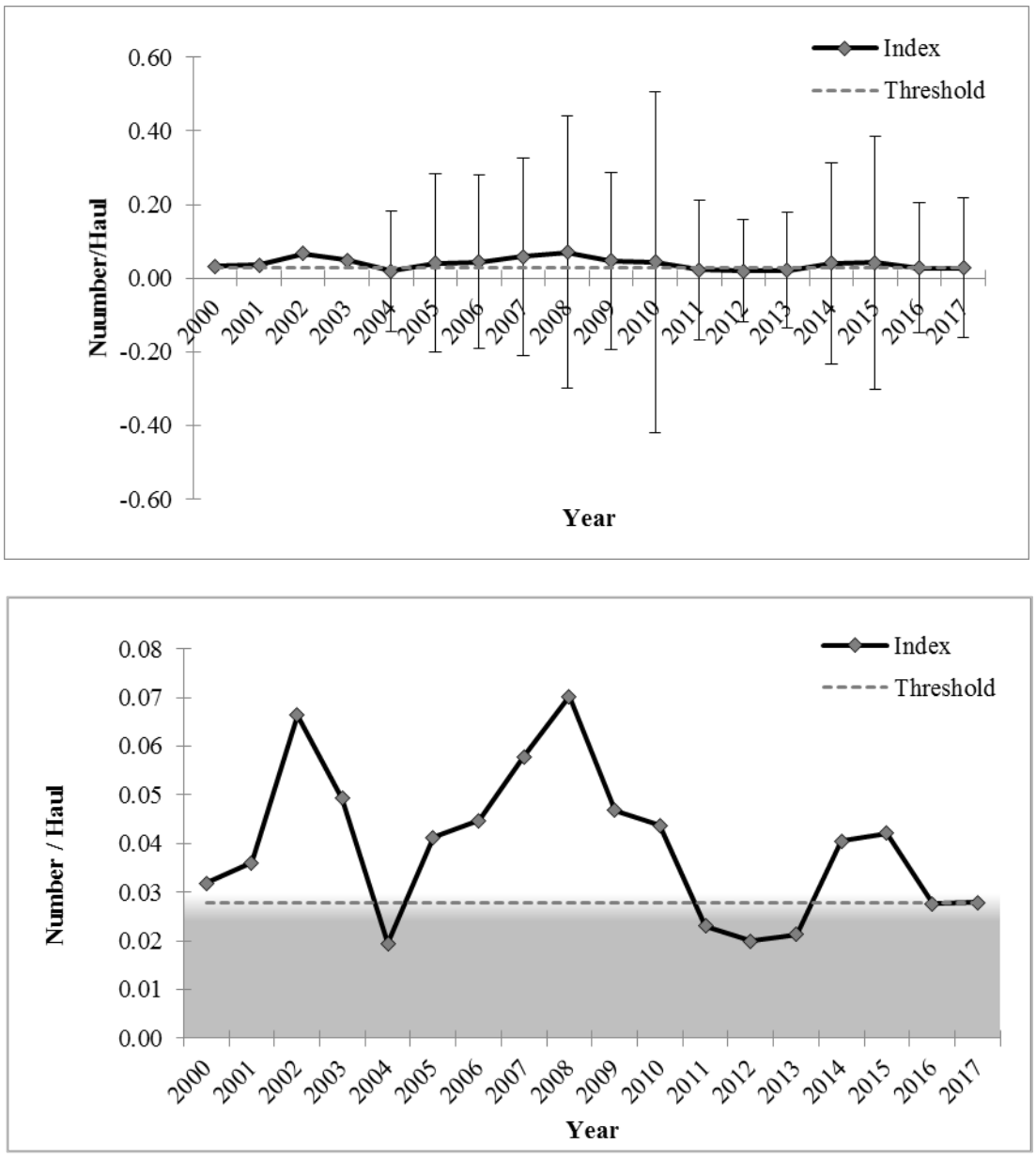
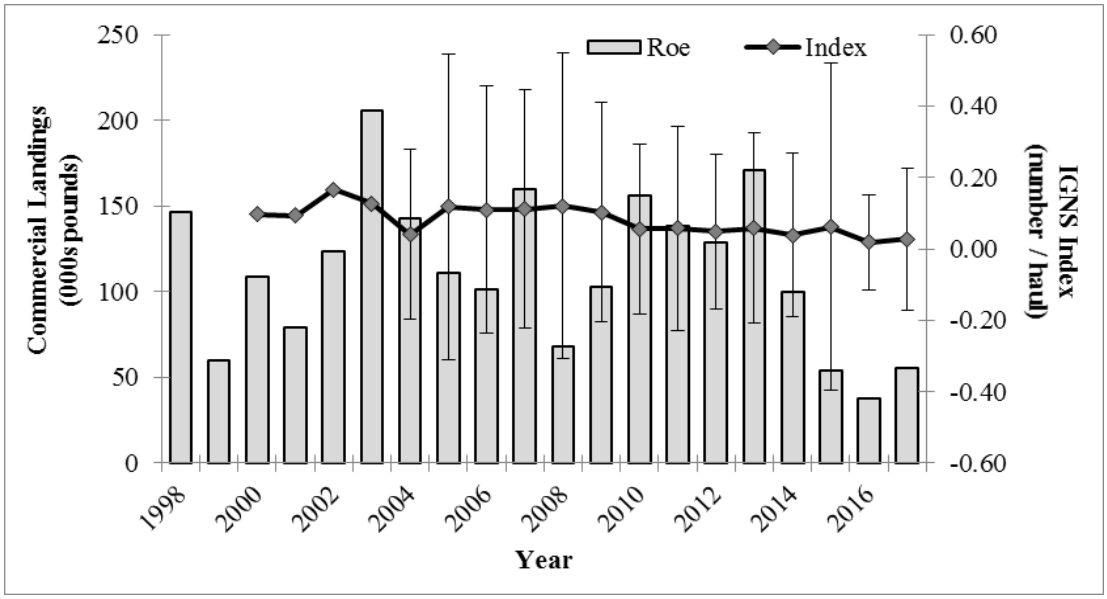


Figure 4. Female index from IGNS (January–May) for Albemarle Sound, 2000–2017. Threshold represents 25th percentile (where 75% of all values are greater). Error bars represent ±1 standard deviation (top graph). Values in gray are below the threshold (bottom graph).



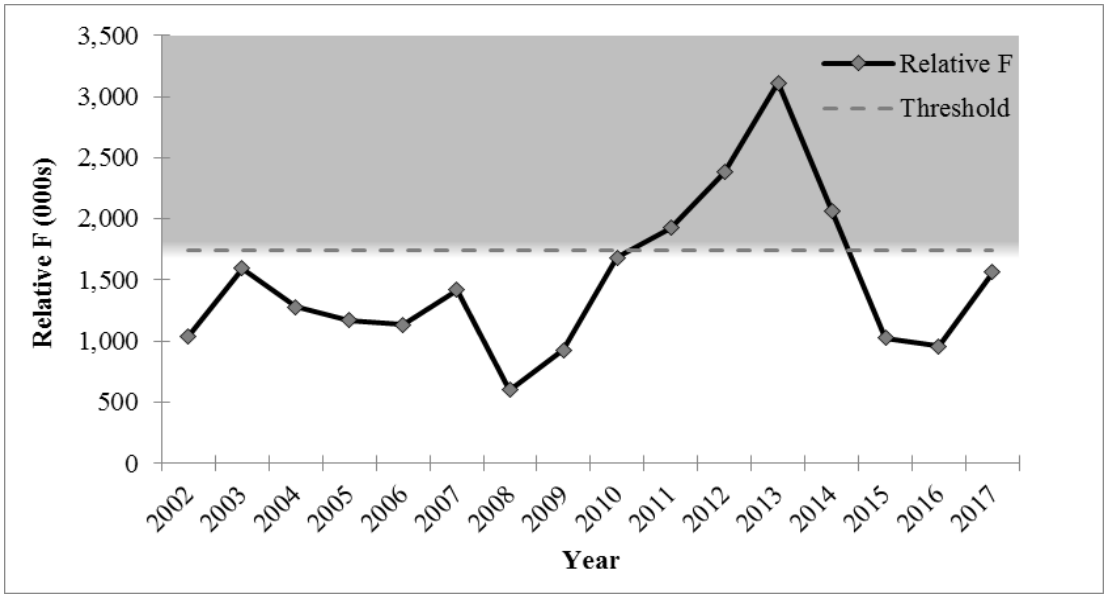


Figure 5**.** Commercial gill net landings of roes (1998-2013 February–April, 2014-2017 March) compared to the female IGNS index (5.0, 5.5 and 6.0-inch mesh sizes, 1998-2013 February–April, 2014-2017 March; top graph) and annual estimates of female relative *F* based on these data (bottom graph) for Albemarle Sound, 2002–2017. The error bars in the top graph represent ±1 standard deviation. The threshold represents the 75th percentile (where 25% of all values are greater), values in gray are exceeding the threshold.

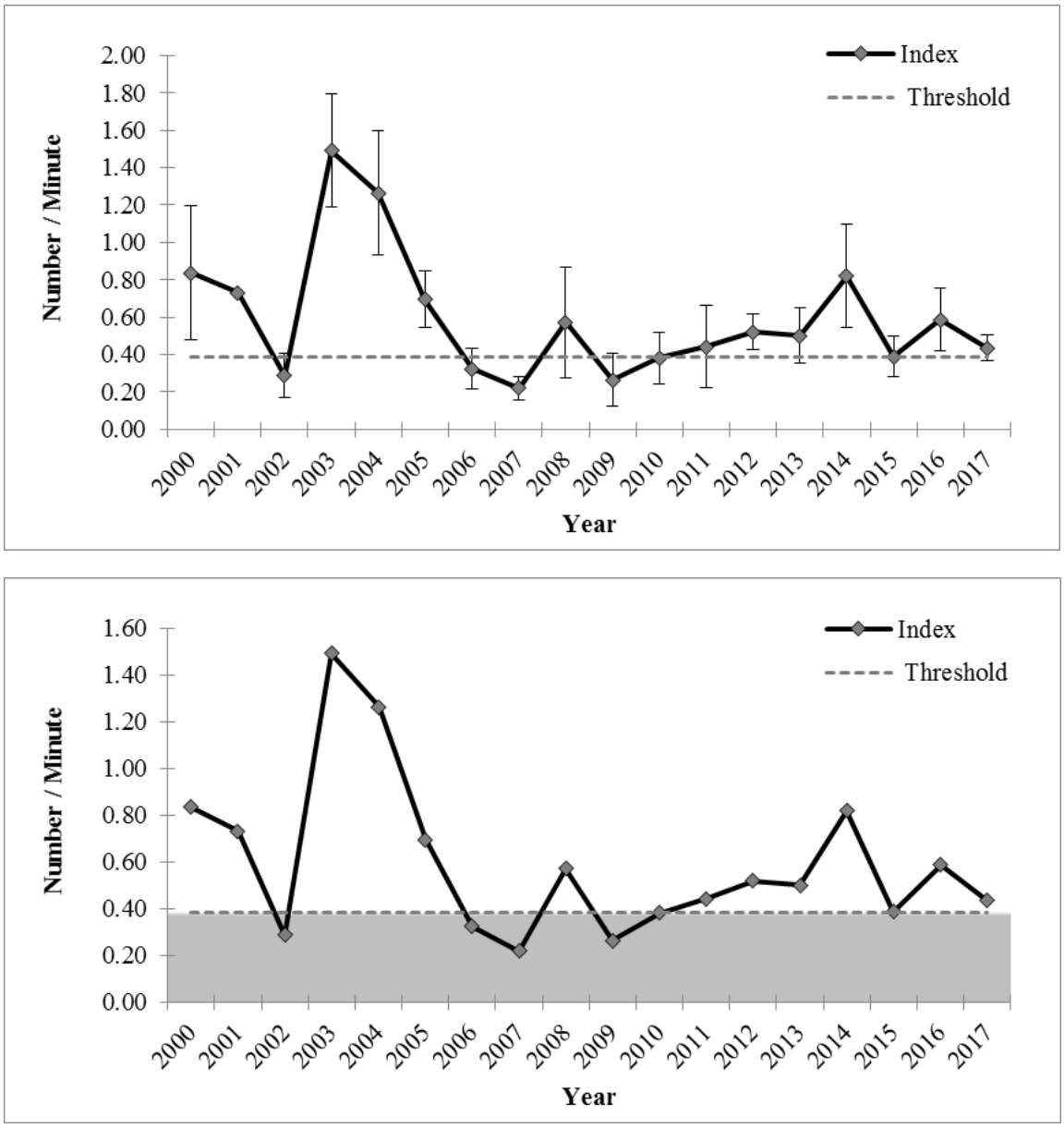


Figure 6. Female electrofishing index (March–May) for the Tar-Pamlico River, 2000–2017. The threshold represents the 25th percentile (where 75% of all values are greater). Error bars represent ±1 standard deviation (top graph). Values in gray are below the threshold (bottom graph).

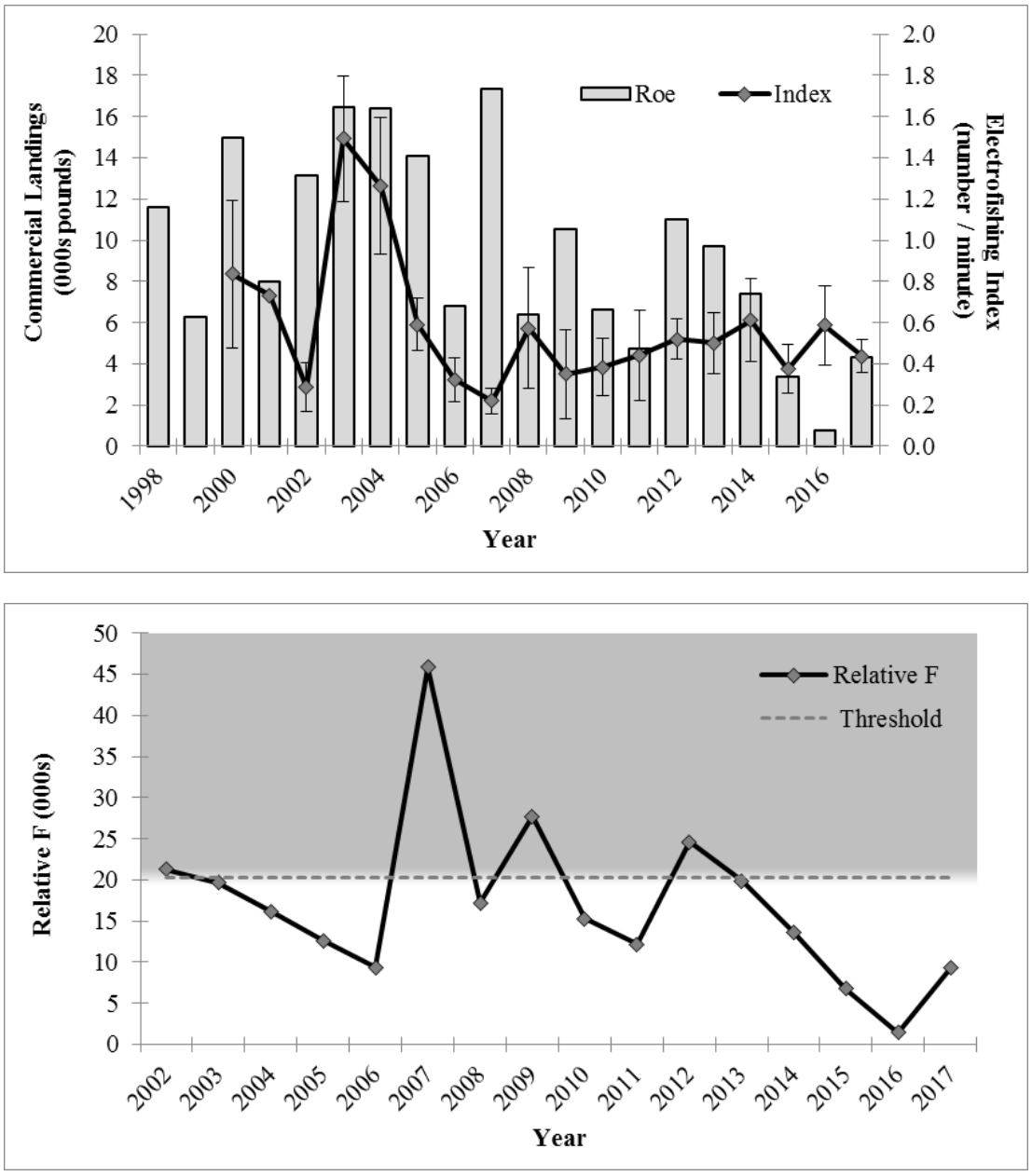


Figure 7. Commercial landings of roes by all gear types (March-April) compared to the female electrofishing index (March–April, 2000-2017; top graph) and annual estimates of female relative *F* based on these data (bottom graph) for the Tar-Pamlico River, 2002–2017. The error bars in the top graph represent ±1 standard deviation. The threshold represents the 75th percentile (where 25% of all values are greater), values in gray are exceeding the threshold.

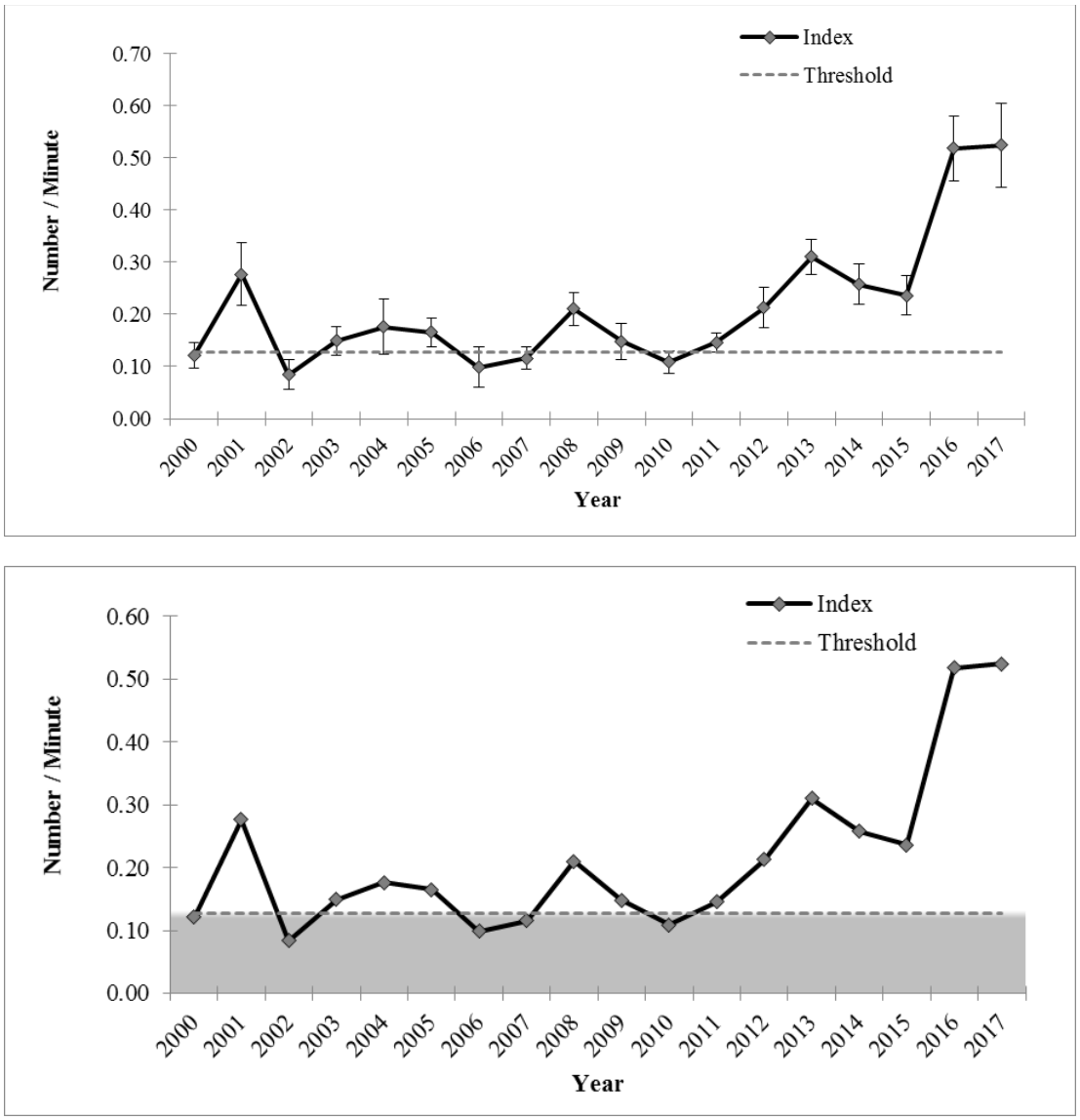


Figure 8. Female electrofishing index (March–May) for the Neuse River, 2000–2017. The threshold represents the 25th percentile (where 75% of all values are greater). Error bars represent ±1 standard deviation (top graph). Values in gray are below the threshold (bottom graph).

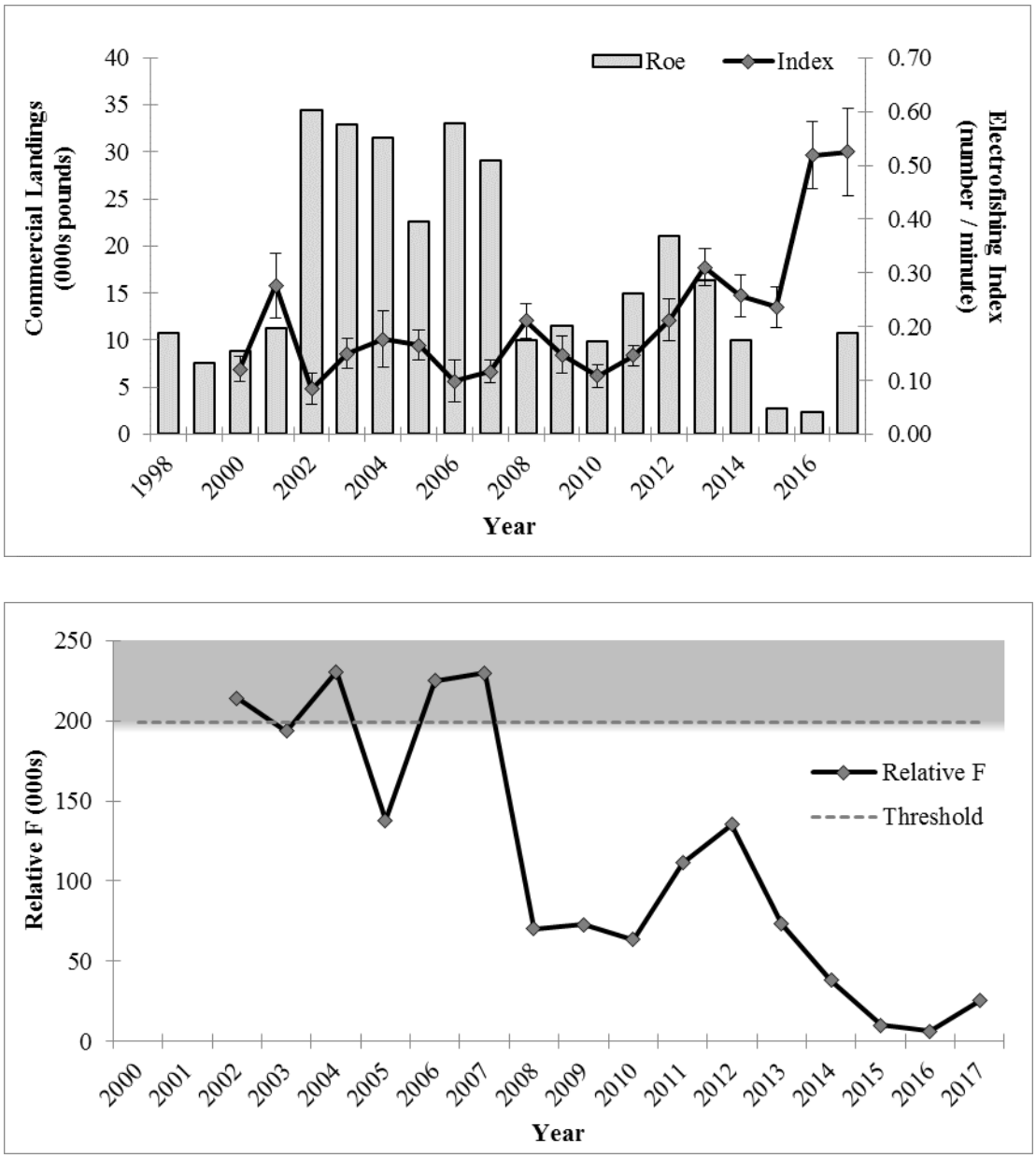


Figure 9. Commercial landings of roes by all gear types (March-April) compared to the female electrofishing index (March-April, 2000-2017; top graph) and annual estimates of female relative *F* based on these data (bottom graph) for the Neuse River, 2002–2017. The error bars in the top graph represent ±1 standard deviation. The threshold represents the 75th percentile (where 25% of all values are greater), values in gray are exceeding the threshold.

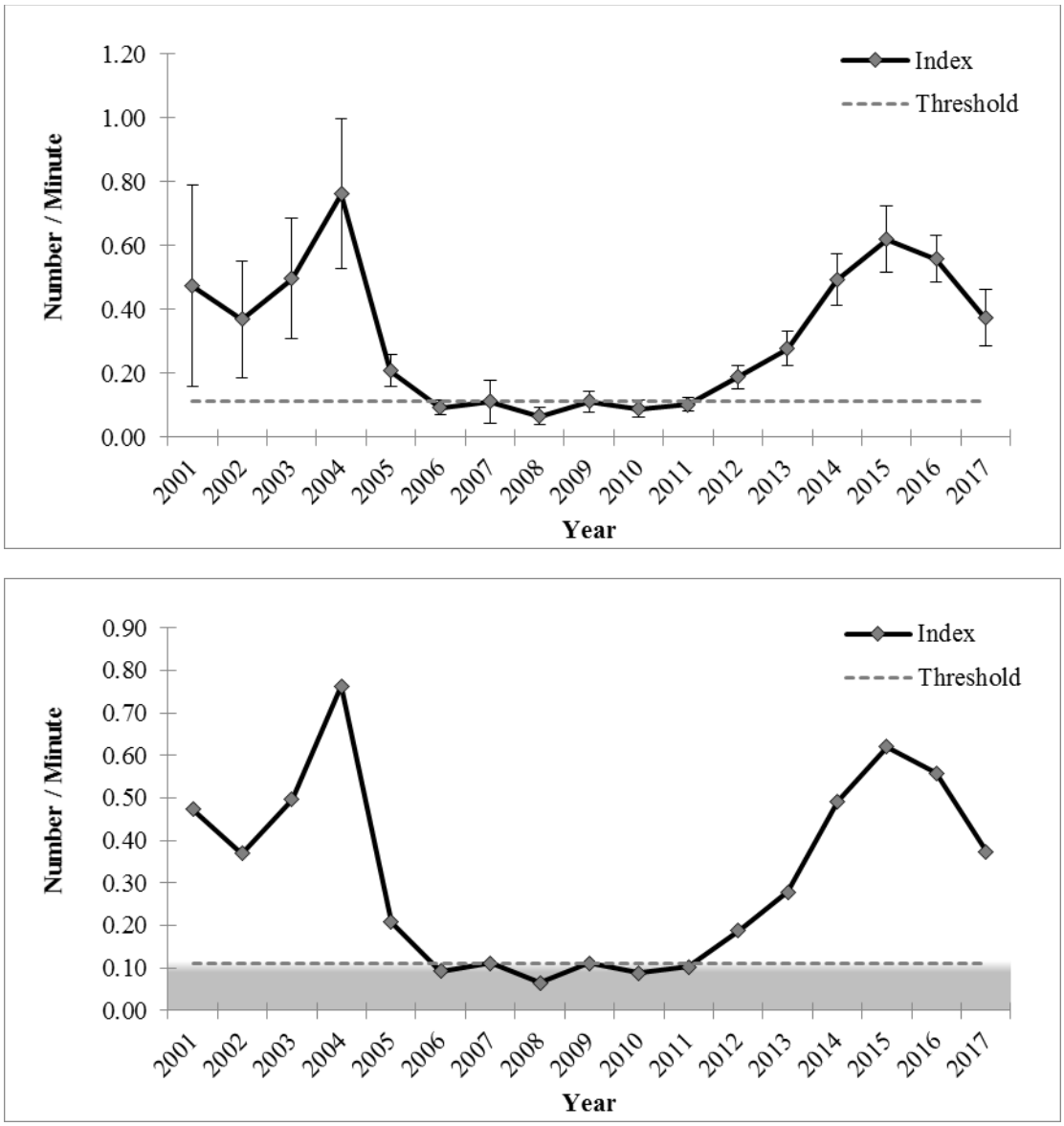


Figure 10. Female electrofishing index (March–May) for the Cape Fear River, 2001–2017. The threshold represents the 25th percentile (where 75% of all values are greater). Error bars represent ±1 standard deviation (top graph). Values in gray are below the threshold (bottom graph).

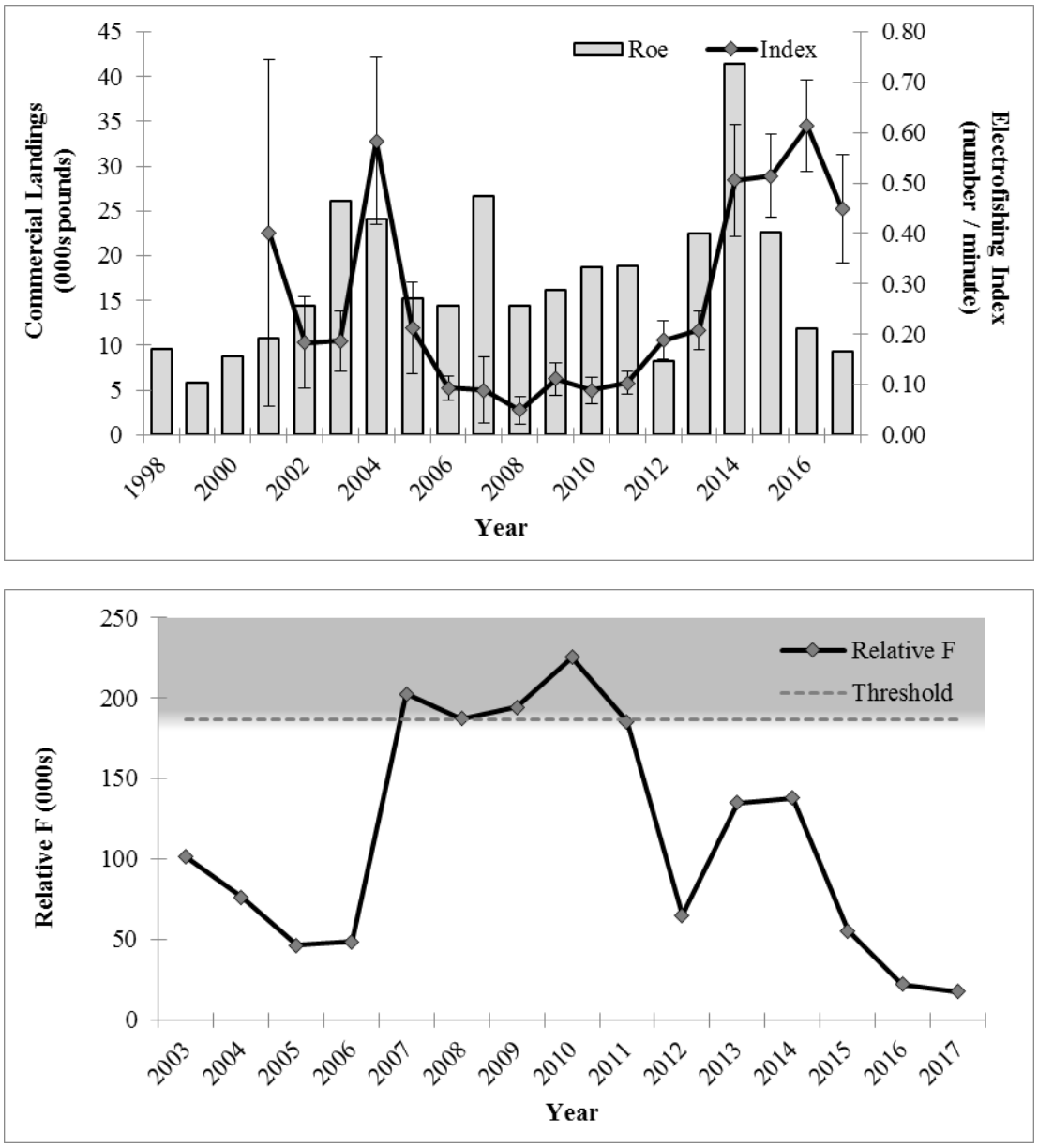


Figure 11. Commercial landings of roes by all gear types (March-April) compared to the female electrofishing index (March-April; top graph) and annual estimates of female relative *F* based on these data (bottom graph) for the Cape Fear River, 2003–2017. The error bars in the top graph represent ±1 standard deviation. The threshold represents the 75th percentile (where 25% of all values are greater), values in gray are exceeding the threshold.

COMMONWEALTH of VIRGINIA

Marine Resources Commission

2600 Washington Avenue
Third Floor
Newport News, Virginia 23607

Molly Joseph Ward
Secretary of Natural Resources

John M.R. Bull
Commissioner

March 22, 2017
Updated September 28, 2017

MEMORANDUM

TO: John Clark, Chair, Shad and River Herring Management Board
Brad Chase, Chair, Shad and River Herring Technical Committee
Caitlin Starks, ASMFC Coordinator, Shad and River Herring Management Plan

FROM: Rob O'Reilly, Virginia Marine Resources Commission, Virginia Representative, Shad and River Herring Management Board

SUBJECT: Request for a limited and sustainable bycatch allowance of American shad for 2018 through 2022

Please accept Virginia Marine Resources Commission's (VMRC) request for a limited bycatch allowance of American shad for 2018 through 2022, as described below. The VMRC is requesting the same conservation measures, in place from 2007 through 2017, be applied to 2018 through 2022. These proposed conservation measures were previously approved by ASFMC in 2012. At the recommendation of the Technical Committee in 2012 to ensure that bycatch amounts remained low, VMRC put in place a cap on the number of licenses issued for 2013 – 2017. The number of permittees had remained at or below 29 individuals since 2008, down from 77 permits issued in 2006 which was the first year the bycatch fishery was allowed. VMRC will only issue 30 permits per year, with preference to past participants. All permittees must allow biological sampling of their catch. Any permittee who do not cooperate or follow reporting procedures will not be issued a permit in the following year. Participation, effort and harvest have remained constant in this fishery, and can be considered sustainable removal rates, especially when compared to other interactions for this species (including other monitoring and restoration efforts).

I. Background

The ASMFC Shad and River Herring Management Board approved a limited bycatch allowance of American shad every year since 2006. The basis for the original request, submitted in November 2005, was to convert dead discards of American shad, taken during the pursuit of other species by select gill net gears, into a small bycatch allowance. The provisions of these approvals were that: (1) the Virginia bycatch fishery would be limited to areas above the James River Bridge, in the James River, the George P. Coleman Bridge, in the York River, and the Norris Bridge, in the Rappahannock River, to ensure that American shad harvested, as bycatch, in other upriver anchored or staked gill net fisheries (e.g. striped bass and Atlantic croaker), were principally Virginia river stocks; (2) the bycatch fishery would be limited to anchor gill net and staked gill net gears, as these gears are associated with spring harvests of spot, croaker, bluefish, catfish, striped bass, and white perch, and discard mortality rates for American shad from these gears are assumed as 100 percent; (3) the bycatch of American shad would be limited to ten American shad per vessel; (4) samples of the American shad bycatch would be collected, especially to distinguish hatchery-origin American shad from wild stocks; and (5) any future bycatch fishery proposals would be reviewed by the ASMFC American Shad and River Herring Technical Committee and Management Board.

The VMRC adopted the conservative measures listed above, for the American shad bycatch allowance, as part of Chapter 4 VAC 20-530-10 et seq., "Pertaining to American Shad." A copy of this regulation is attached, and all provisions for the bycatch fishery specified by the ASMFC management board were adopted by the VMRC (Appendix I.). In addition, the VMRC made it unlawful to possess or land any bycatch of American shad unless an equal number of croaker, spot, striped bass, bluefish, catfish, or white perch were also possessed.

II. Proposal for a Sustainable Bycatch Allowance of American Shad 2018 -2022

The VMRC requests your approval for a sustainable bycatch allowance of American shad, under conditions described below:

1) All management provisions of the 2013 through 2017 American shad bycatch allowance, would be maintained from 2018 through 2022 and, 2) the VMRC proposes to continue the Technical committee recommended cap on the number of permits that can be issued annually at 30.

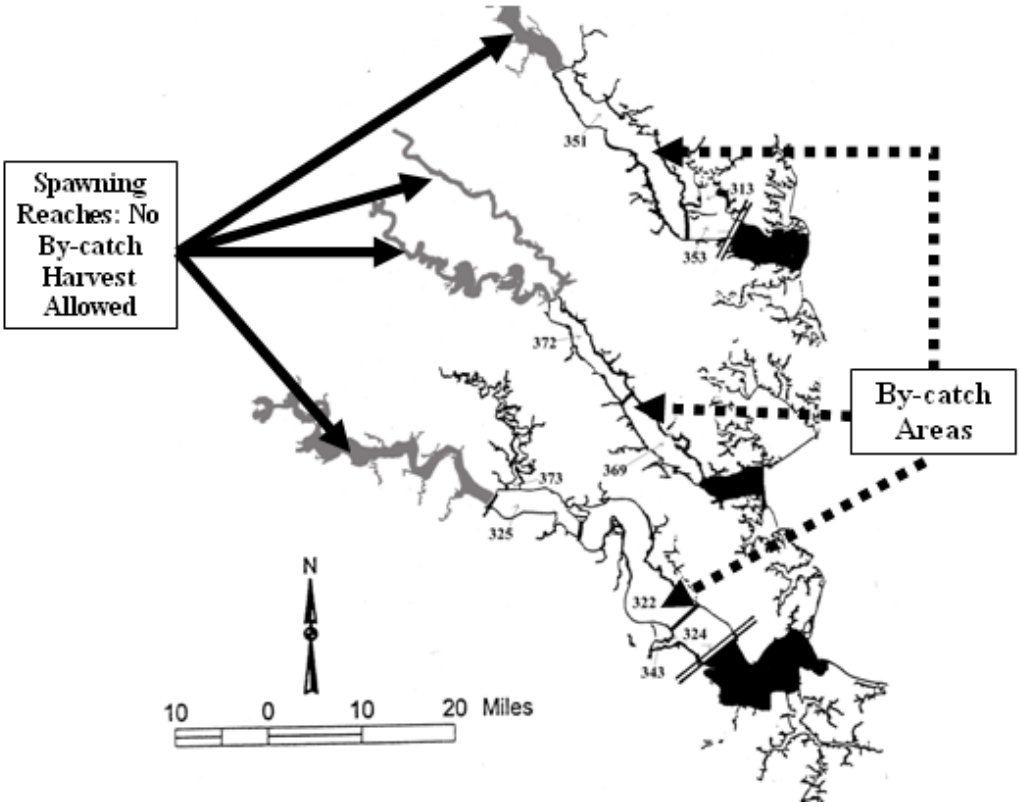


Figure 1. American shad bycatch areas, (in white) above the first bridges of the James, York, and Rappahannock rivers.

A determination of the approximate extent of Virginia's bycatch of American shad, from all gear types, in all areas throughout the Chesapeake Bay system, is an important objective for a better understanding of these stocks. The upriver anchored and staked gill net bycatch fishery, coupled with recent Virginia Institute of Marine Science's (VIMS) efforts to estimate bycatch from pound nets and other gear, currently represent the best method, for achieving this objective. The VMRC is requesting that waste (dead discards of American shad associated with spring fisheries, for specific gill net gear) be converted to usable product. A continuation of this American shad bycatch allowance, from 2018 through 2022, in the bycatch areas, will not challenge the health of these riverine stocks of American shad, but will allow Virginia to meet FMP sampling requirements. All Bycatch permittees agree to allow VIMS to sample their catch, and VIMS is given a weekly update, beginning in February, of any permits issued. Sampling of the permitted bycatch can assist in collection of age, size and sex composition of the adult population and provide another opportunity for the assessment of hatchery contribution to these stocks.

The Virginia Department of Game and Inland Fisheries (VDGIF) will continue its stocking program in the James River, and continue a hatchery evaluation in the James, York and Rappahannock rivers. The VDGIF will also continue push net surveys in the James and Rappahannock rivers, to monitor juvenile population trends. In addition to the push net surveys, the VIMS will continue to provide juvenile abundance indices (JAIs), for all three

river systems. The JAIs are provided in the annual compliance report to the ASMFC. The VIMS will also continue to provide catch rates, annual mortality estimates and biological data (age composition, length frequencies, sex ratio, and degree of repeat spawning), for stock assessment purposes.

The losses of American shad from monitoring and restoration projects have surpassed the modest losses recorded from the bycatch allowance in all years (four percent of total losses were attributed to the bycatch fishery, with 96 percent of removals from monitoring and restoration efforts in 2011 (see Table 1 of the compliance report). The losses from the bycatch fishery cannot inhibit the benchmark restoration goals, when compared to the losses directly resulting from the restoration and other monitoring efforts. The bycatch allowance enables bycatch monitoring of American shad as required by Amendment 3 to the FMP. If the permitted bycatch allowance was not in place, the harvesters directing efforts on striped bass, Atlantic croaker, catfish, or menhaden would not be required to report American shad discards and this information would be unknown.

The VMRC is requesting that the ASMFC Shad and River Herring Management Board review this sustainable American shad bycatch allowance proposal, for continuation through 2022, at its August 2017 meeting.

III. Results from the limited 2015 Virginia bycatch fishery for American shad

All American shad bycatch allowable permittees were required to report their harvest, in pounds of American shad retained, to the VMRC Mandatory Reporting System, a system that requires all harvesters to report all daily harvest and effort data on a monthly basis. Monthly mandatory reports include type and amount of gear used, water body fished, gear soak time, and all species retained. The majority of American shad reported to the mandatory reporting database were in pounds; however, a few individuals reported to the mandatory reporting system in numbers. Using the calculated average weight, the mandatory reporting database converts numbers to pounds, based on an average weight per American shad of 3.57 pounds. A total of 1,185 pounds of American shad was reported, as harvested in 2015, to the mandatory reporting database. Using the conversion factor of 3.57 pounds per fish, that harvest corresponds to 332 American shad.

In addition to the permitted fishermen's requirement to reported catch and harvest, on a daily basis, to the Mandatory Reporting System, all fishermen permitted for the American shad bycatch fishery were required to call an Interactive Voice Response System (IVRS), for each preceding weekly period and provide the following information: name, registration number, number of fishing trips taken, water body fished, number of nets set, number of American shad caught, and number retained. All American shad in the IVRS database were reported in numbers, and a total of 343 American shad were reported as harvested to the IVRS in 2015. Using the same conversion used in the mandatory reporting database, that corresponds to 1,225 pounds of harvested American shad.

The two databases (IVRS-basis and mandatory reporting database) were reconciled by comparing data on a case-by-case basis. If the number of fish reported to the IVRS was converted to equal the pounds of American shad reported to the mandatory reporting

system, a 3.45 pound average per fish would be the result. There is a slight discrepancy between the computed weight of the two databases, and this is partly due to the different average weight data used for converting numbers to pounds.

It was beneficial to have two types of reporting systems in place, to monitor the bycatch of American shad. This allowed the VMRC to note several discrepancies between call-in reports to the IVRS and the mandatory reporting monthly reports. Through comparisons of these systems, fish that had been coded incorrectly as American shad were identified, and the errors were corrected in the mandatory reporting database.

In 2015, 29 bycatch permits were issued between the months of February and March. The number of permittees has remained at or below 29 individuals since 2008, with most of the same individuals remaining in the fishery. The number of permittees decreased from 77 permits issued in 2006 to 38 permits issued in 2007. Of the 29 permit holders, 22 reported harvesting any American shad in 2015 (Table 1).

Table 1. Number of fishermen with American shad by-catch permits, active permits, and fishing activity reported by river system January through May, 2006-2016. Permits are considered active if one or more pounds of American shad were reported. Total trips are the total number of gill net trips taken by active permit holders during this time period. *In 2010 one fisherman in the Rappahannock River did not record the total number of shad caught, so 40 was used.

Water Body	Year	# Permit Holders	# Active Permits	Total Trips	# Shad Caught	# Shad Kept	% of Bycatch for Year
James River	2015	14	8	58	31	21	8
	2014	14	9	54	114	112	15
	2013	10	4	55	150	139	32
	2012	10	2	7	10	7	3
	2011	9	3	25	42	42	32
	2010	9	0	7	0	0	0
	2009	8	1	6	2	0	0
	2008	6	2	3	3	3	2
	2007	16	7	58	119	52	19
	2006	32	5	27	24	23	9
York River	2015	10	9	36	302	279	76
	2014	8	5	85	453	453	61
	2013	12	6	116	212	203	47
	2012	13	5	71	207	207	94
	2011	11	4	51	88	87	67
	2010	9	5	43	229	208	84
	2009	11	6	97	302	288	100
	2008	10	6	85	89	89	60
	2007	15	8	104	199	199	73
	2006	31	5	198	233	228	90
Rappahannock River	2015	6	5	25	63	63	16
	2014	8	4	49	182	173	23
	2013	7	6	24	273	89	21
	2012	2	1	2	7	7	3
	2011	3	1	1	1	1	1
	2010	7	2	10	40*	40*	16
	2009	1	0	0	0	0	0
	2008	3	1	8	81	57	38
	2007	5	2	23	22	20	7
	2006	14	2	8	3	3	2

IV. Harvest Bycatch Allowance Monitoring

For the bycatch fishery, it is unlawful for any person to possess aboard a vessel or land any American shad, unless that person possessed at least an equal number of fish of only the following food-grade species: spot, Atlantic croaker, bluefish, catfish, striped bass, or white perch. A comparison of trip and effort data has been summarized, for these species, by permitted gill net gear during January through April, by water area, for 2015 (Table 2). According to permitted fishermen's past harvest activity, using anchor or staked gill net, the majority of these fishermen harvested species other than American shad prior to 2006 (first year the bycatch was allowed), from the same areas they have recently been allowed to retain bycatch of American shad.

Table 2. Harvest (pounds) by species and bycatch area during January through April 2015. All harvest is from anchored and staked gill nets (not exclusive to American Shad bycatch permit holders). Bait includes fish reported as bait and menhaden.

Bycatch Area	Am Shad	Atlantic Croaker	Bait and Menhaden	Catfish	Hickory Shad	Striped Bass	White Perch
James River	51	1,999	71,400	67,444	46	104,745	4,923
Rappahannock River	239	4,197	230,622	18,047	51	79,464	24,378
York River	895	5,974	821,403	14,286	.	25,370	8,539
Total	1,185	12,170	1,123,425	99,777	97	209,579	37,839

The total number of anchored and staked gill net trips during the months of February through April, for any species, by year (Table 3; Figure 2), was again included in this summary report to track the overall effort in the areas where bycatch has been approved by the ASMFC. The VMRC will continue to report on all activity in the area as well as the effort of those permitted for the American shad bycatch fishery. The harvest in the bycatch areas by all anchored and staked gill net trips was composed primarily of catfish, striped bass, Atlantic croaker, and bait (mostly menhaden). The top three species by weight, when American shad were actually retained by permitted fishermen as bycatch, were striped bass, catfish, and Bait (Table 4).

Table 3. Trip and effort data summarized for all species harvested by anchored (sink) and staked gill nets during the months of February through April, by water body, from 2003 through 2015.

Year	James River	Rappahannock River	York River	Grand Total
2003	358	630	465	1,453
2004	318	575	607	1,500
2005	247	536	515	1,298
2006	321	504	660	1,485
2007	367	329	557	1,253
2008	313	490	387	1,190
2009	392	656	783	1,831
2010	412	816	581	1,809
2011	361	794	446	1,601
2012	318	712	611	1,641
2013	380	723	645	1,748
2014	590	818	717	2,125
2015	391	622	519	1532

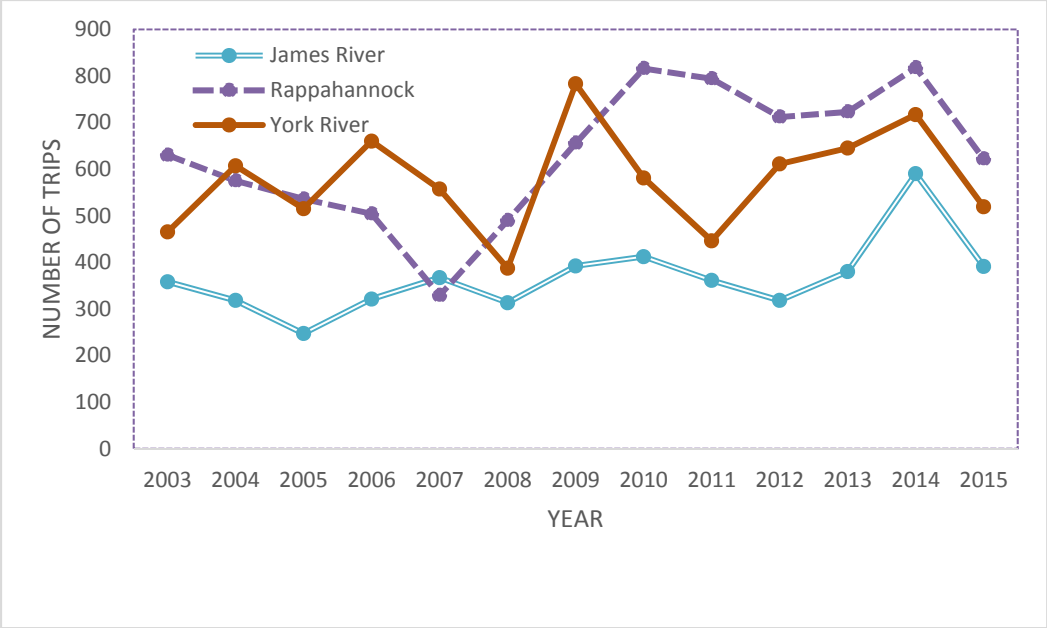


Figure 2. Total anchored and staked gillnet trips in the American shad bycatch areas from February through April, 2003 through 2015 (not exclusive to American shad bycatch permit holders). All species are included.

Table 4. Profiles of American shad bycatch permittees for 2015, including harvest totals, by species, for those trips where American shad were retained.

Harvester ID	American Shad	Croaker	Bait*	Bluefish	Catfish	Gizzard shad	Hickory Shad	Striped Bass	White Perch
1	39	13	40	14	164	.	8	.	.
2	2	.	.	.	229	.	.	490	.
3	39	.	.	.	1,459	.	.	2,588	.
4	5	.	.	.	.	.	.	265	.
5	278	.	.	.	565	.	.	.	.
6	490	70	60	.	540	60	.	.	.
7	15	15	350	.	150	.	.	.	.
8	10	.	.	.	508	.	.	391	.
9	86	.	.	.	310	.	.	154	.
10	56	.	360	.	.	.	.	479	.
11	50	75	71	2	.	.	.	.	2
12	115	26	1,300	.	3,138	275	1	.	207
Total	1,185	199	2,181	16	7,063	335	9	4,367	209

*Bait category is primarily comprised of menhaden

Table 5. American shad bycatch in numbers from each bycatch area from 2006 to 2015 from the IVRS database.

Bycatch Area	James River	York River	Rappahannock River	Total
2006	23	228	3	254
2007	52	199	20	271
2008	3	89	57	149
2009	--	288	--	288
2010	--	208	40	248
2011	47	47	1	95
2012	7	219	7	233
2013	139	203	89	431
2014	112	453	173	738
2015	21	279	43	343
Total	404	2,213	433	3,050

V. 2016 Bycatch Fishery Summary

The 2016 Virginia bycatch fishery for American shad adhered to all guidelines established by the ASMFC. The VMRC has maintained a permitting system, based on specific criteria, that includes use of gear (staked and anchor gill nets) associated with high mortality of captured American shad. Monitoring of participating harvesters is accomplished using two separate mandatory reporting systems. The IVRS was established with specific reporting requirements placed on each permitted fisherman. In addition, corroboration of harvesting activities gathered from the IVRS was enabled through a second reporting system, the VMRC Mandatory Reporting System. The preliminary harvest for 2016 shows 11 active harvesters, reporting 338 pounds which corresponds to 95 American Shad.

VI. References

Atlantic States Marine Fisheries Commission (ASMFC). 2010. Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management). 158 pp.

Appendix I.

VIRGINIA MARINE RESOURCES COMMISSION
"PERTAINING TO AMERICAN SHAD"
REGULATION 4 VAC 20-530-10 ET SEQ.

PREAMBLE

This chapter establishes a moratorium on the harvest of American shad and provides for a limited bycatch of American shad during the 2012 fishing season. This chapter is promulgated pursuant to the authority contained in § 28.2-201 of the Code of Virginia. This chapter amends and re-adopts, as amended, previous Chapter 4VAC20-530-10 et seq. which was adopted on February 22, 2011 and made effective on March 1, 2011. The effective date of this chapter, as amended, is February 1, 2012.

4VAC20-530-10. Purpose.

The purposes of this chapter are to rebuild the Virginia stocks of American Shad and to comply with the requirements for ocean intercept commercial fisheries as specified by the Interstate Fishery Management Plan for Shad and River Herring.

4VAC20-530-20. Definition.

The following words and terms when used in this chapter shall have the following meanings unless the context clearly indicates otherwise.

"Bycatch area" means those tidal waters of (i) the James River, from the James River Bridge upstream to a line connecting Dancing Point and New Sunken Meadow Creek; (ii) the York River, from the George P. Coleman Bridge upstream to the Rt. 33 Eltham and Lord Delaware bridges at West Point; and (iii) the Rappahannock River, from the Norris Bridge upstream to the Rt. 360 Downing Bridge at Tappahannock.

"Chesapeake Bay" means all Virginia tidal waters west of the Colregs Demarcation Line that connect the Cape Henry Lighthouse in Virginia Beach to the Cape Charles Lighthouse on Smith Island.

"Coastal area" means all Virginia tidal waters east of the Colregs Demarcation Line that connect the Cape Henry Lighthouse in Virginia Beach to the Cape Charles Lighthouse on Smith Island.

4VAC20-530-23 to 4VAC20-530-29. [Repealed]

4VAC20-530-30. Moratorium.

A. It shall be unlawful for any person to catch and retain possession of American shad from the Chesapeake Bay, except as described in 4VAC20-530-31.

B. It shall be unlawful for any person to possess aboard a vessel or land in Virginia any American shad harvested from the coastal area.

C. It shall be unlawful for any person to possess any American shad taken from the coastal area or the Chesapeake Bay, except as described in 4VAC20-530-31.

4VAC20-530-31. Bycatch fishery.

A. Any registered commercial fisherman meeting the conditions described in this subsection shall be eligible to participate in the American shad bycatch fishery in 2012:

1. The registered commercial fisherman shall apply for a VMRC American Shad Bycatch Permit and possess that permit while fishing, landing, or selling his catch of American shad.

2. The registered commercial fisherman shall complete the VMRC American Shad Bycatch Survey form to describe his pending fishing activity.

B. It shall be unlawful for any person to possess aboard a vessel more than 10 American shad. When more than one registered and permitted fisherman is fishing on the same vessel, it shall be unlawful to possess more than 10 American shad aboard that vessel.

C. It shall be unlawful for any person to possess aboard a vessel or land any American shad unless that person possesses at least an equal number of fish of only the following food-grade species: spot, croaker, bluefish, catfish, striped bass or white perch.

D. Possession of American shad by any person permitted in accordance with this section shall be lawful only when those American shad were harvested from the bycatch area. Possession of any American shad harvested in Virginia waters that are outside of the bycatch area shall constitute a violation of this regulation.

E. American shad harvested only as bycatch by anchored gill nets and staked gill nets may be possessed or retained for sale in accordance with the provisions of this regulation. It shall be unlawful for any person to harvest, land, or possess any American shad taken by any recreational gear or by any commercial gear, except anchored gill net or staked gill net.

F. Every fisherman permitted for the American shad bycatch fishery shall contact the commission's interactive voice response system once weekly to report the following for the preceding weekly period: name, registration number, number of fishing trips taken, water body fished, number of nets set, number of American shad caught and number retained.

4VAC20-530-32. [Repealed]

4VAC20-530-35. [Repealed]

4VAC20-530-40. Penalty.

As set forth in §28.2-903 of the Code of Virginia, any person violating any provision of this chapter shall be guilty of a Class 3 misdemeanor, and a second or subsequent violation of any provision of this chapter committed by the same person within 12 months of a prior violation is a Class 1 misdemeanor.

REVIEW OF THE ATLANTIC STATES MARINE FISHERIES COMMISSION FISHERY MANAGEMENT PLAN FOR SHAD AND RIVER HERRING *(Alosa spp.)* FOR THE 2016 FISHING YEAR

Shad & River Herring Plan Review Team
Caitlin Starks, Atlantic States Marine Fisheries Commission (Chair)
Mike Dionne, New Hampshire Fish and Game Department
Heather Corbett, New Jersey Division of Fish and Wildlife
Phil Edwards, Rhode Island Division of Fish and Wildlife
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For Board Review October 2017

REVIEW OF THE ASMFC FISHERY MANAGEMENT PLAN FOR SHAD AND RIVER HERRING *(Alosa spp.)*

I. Status of the Fishery Management Plan

Date of FMP Approval:	October 1985
Amendments:	Amendment 1 (April 1999) Amendment 2 (August 2009) Amendment 3 (February 2010)
Addenda:	Technical Addendum #1 (February 2000) Addendum I (August 2002)
Management Unit:	Migratory stocks of American shad, hickory shad, alewife, and blueback herring from Maine through Florida
States With Declared Interest:	Maine through Florida, including the Potomac River Fisheries Commission and the District of Columbia
Active Boards/Committees:	Shad & River Herring Management Board, Advisory Panel, Technical Committee, Stock Assessment Subcommittee, Plan Review Team, Plan Development Team

The 1985 Fishery Management Plan (FMP) for Shad and River Herring was one of the very first FMPs developed at the ASMFC. Amendment 1 was initiated in 1994 to require and recommend specific monitoring programs to inform future stock assessments—it was implemented in October 1998. A Technical Addendum to Amendment 1 was approved in 1999 to correct technical errors.

The Shad and River Herring Management Board (Board) initiated Addendum I in February 2002 to change the conditions for marking hatchery-reared alosines; clarify the definition and intent of *de minimis* status for the American shad fishery; and modify and clarify the fishery-independent and dependent monitoring requirements. These measures went into effect on January 1, 2003.

In August 2009, the Board initiated Amendment 2 to restrict the harvest of river herring (blueback herring and alewife) due to observed declines in abundance. The Amendment prohibited commercial and recreational river herring fisheries in state waters beginning January 1, 2012, unless a state or jurisdiction has a sustainable management plan reviewed by the Technical Committee and approved by the Board. The Amendment defines a sustainable fishery as "a commercial and/or recreational fishery that will not diminish the potential future stock reproduction and recruitment." Amendment 2 required states to implement fisheries-dependent and independent monitoring programs. Sustainable fishery management plans have been approved by the Management Board for Maine, New Hampshire, Massachusetts, New York, North Carolina and South Carolina (Table 1).

In February 2010, the Board initiated Amendment 3 in response to the 2007 American shad stock assessment, which found most American shad stocks at all-time lows. The Amendment requires similar management and monitoring as developed in Amendment 2 (for river herring). Specifically, Amendment 3 prohibits shad commercial and recreational fisheries in state waters beginning January 1, 2013, unless a state or jurisdiction has a sustainable management plan reviewed by the Technical Committee and approved by the Board. The Amendment defines a sustainable fishery as "a commercial and/or recreational fishery that will not diminish the potential future stock reproduction and recruitment." The Amendment allows any river systems to maintain a catch and release recreational fishery. Sustainable fishing plans have been approved by the Board for Florida, Georgia, South Carolina, North Carolina, the Potomac River Fisheries Commission, and the Delaware River Basin Fish Cooperative (on behalf of New York, Delaware, New Jersey, and Pennsylvania) and Connecticut (Table 1). All states and jurisdictions are also required to identify local significant threats to American shad critical habitat and develop a plan for mitigation and restoration. All states and jurisdictions habitat plans have been accepted and approved.

Table 1. States with approved sustainable fishery management plans (SFMP) for river herring or shad. Includes year of Board approval and year the Board approved the updated[1] SFMP.

State	River Herring SFP	Shad SFP
Maine	Approved (2010, 2017)	
New Hampshire	Approved (2011, 2015)	
Massachusetts	Approved (2016)	
Connecticut		Approved (2012)
Rhode Island		
Pennsylvania		Approved* (2012, 2017)
New York	Approved (2011, 2017)	Approved* (2012, 2017)
New Jersey		Approved*(2012, 2017)
Delaware		Approved*(2012, 2017)
PRFC		Approved (2012)
Maryland		
Virginia		
North Carolina	Approved (2010)	Approved (2012)
South Carolina	Approved (2010, 2017)	Approved (2011)
Georgia		Approved (2012)
Florida		Approved (2011, 2017)

*Delaware River Basin Fish and Wildlife Management Co-op has a Shad SFP, though Delaware and New Jersey are only states that have commercial fisheries. All states have recreational measures, with limited to no catch in the upper Delaware River (New York & Pennsylvania).

[1] SFMPs have to be updated and re-approved by the Board every five years.

II. Status of the Stocks

While the FMP addresses four species: two river herrings (blueback herring and/or alewife) and/or two shads (American shad and/or hickory shad)—these are collectively referred to as shad/river herring, or S/RH.

The most recent *American shad stock assessment report* (ASMFC 2007) identified that American shad stocks are highly depressed from historical levels. Of the 24 stocks of American shad for which sufficient information was available, 11 were depleted relative to historic levels, 2 were increasing, and 11 were stable (but still below historic levels). The status of 8 additional stocks could not be determined because the time-series of data was too short or analyses indicated conflicting trends.

Taken in total, American shad stocks do not appear to be recovering. The assessment concluded that current restoration actions need to be reviewed and new ones need to be identified and applied. These include fishing rates, dam passage, stocking, and habitat restoration. There are no coastwide reference points for American shad. There is no stock assessment available for hickory shad. A stock assessment update is scheduled for 2018 to analyze American shad stock status.

The most recent benchmark *river herring stock assessment report* (ASMFC 2012) indicated, of the 24 river herring stocks for which sufficient data were available to make a conclusion, 23 were depleted relative to historic levels and one was increasing. The status of 28 additional stocks could not be determined because the time-series of available data was too short.

Estimates of coastwide abundance and fishing mortality could not be developed because of the lack of adequate data. The “depleted” determination was used instead of “overfished” because of the many factors that have contributed to the declining abundance of river herring, which include not just directed and incidental fishing, but likely also habitat issues (including dam passage, water quality, and water quantity), predation, and climate change. There are no coastwide reference points.

The river herring stock assessment was updated in 2017 (ASMFC 2017) with additional data from 2011-2015, and indicates that river herring remain depleted at near historic lows on a coastwide basis. Total mortality estimates over the final 3 years of the data time series (2013-2015) are generally high and exceed region-specific reference points for some rivers. However, there are some positive signs of improvement for some river systems. Total mortality estimates for 2 rivers have fallen below region-specific reference points during the final 3 years of the data time series. No total mortality estimates were below reference points at the end of the 2012 stock assessment data time series. Of the 54 stocks for which data were available, 16 experienced increasing abundance trends, 2 experienced decreasing abundance trends, 8 experienced stable abundance and 10 experienced no discernable trend in abundance over the final 10 years of the time series (2006-2015).

III. Status of the Fisheries

Shad and river herring formerly supported important commercial and recreational fisheries throughout their range. Historically fishing took place in rivers (both freshwater and saltwater), estuaries, tributaries, and the ocean. Although recreational harvest data are scarce, most harvest is believed to come from the commercial industry. Commercial landings for these species have declined dramatically from historic highs. The following summarizes each fishery:

AMERICAN SHAD:

Total combined river and ocean commercial landings decreased from a high of 2,364,263 pounds in 1985 to a low of 1,390,512 pounds in 1999, but increased in 2000 to 1,816,979 pounds. The 2005 closure of the ocean-intercept fishery (phase out started in 2000) has substantially lowered the coastwide total landings of American shad. The total landings reported in compliance reports from individual states and jurisdictions in 2016 was 239,067 pounds, a 50% decrease from landings in 2015 (478,688 pounds) (Table 2).

In 2016, landings from North Carolina and South Carolina accounted for 26% and 32% of the commercial harvest, respectively. The remainder of the harvest came from Maine, Connecticut, New York, New Jersey, Delaware, Maryland[1], PRFC, Virginia, and Georgia. In 2016 New Hampshire, Massachusetts, Rhode Island, Pennsylvania, District of Columbia and Florida reported no directed shad harvest in their state compliance reports.

Substantial shad recreational fisheries occur on the Connecticut (CT and MA), Delaware (NY, PA and NJ), Susquehanna (MD), Santee and Cooper (SC), Savannah (GA), and St. Johns (FL) Rivers. Shad recreational fisheries are also pursued on several other rivers in Massachusetts, District of Columbia, Virginia, North Carolina, South Carolina, and Georgia. Tens of thousands of shad are caught by hook and line from large east coast rivers each year, but detailed creel surveys are generally not available. Actual harvest (catch and removal) may amount to only about 20-40% of total catch, but hooking mortality could boost this "harvest" value substantially. Several comprehensive angler use and harvest surveys are planned or have been recently completed. In January 2007, the Management Board suspended the requirement to monitor the recreational fishery until the stock assessment had been completed and a template for creel surveys had been developed.

Since 2009, MRFSS/MRIP data are no longer provided for American shad. This is a result of the unreliable design of MRFSS/MRIP that focuses on active fishing sites along coastal and estuarine areas. In previous years the proportional standard error (PSE) has ranged from 0-100.

HICKORY SHAD:

In 2016, Virginia, North Carolina, South Carolina, and Georgia reported hickory shad landings. North Carolina accounts for a vast majority of the landings with 96%. The coastwide commercial

[1] Maryland commercial fishermen are permitted a 2 fish per day allowance of dead American shad for personal use; no sale is permitted

landings were 100,079 pounds in 2016, representing a 35% decrease from 2015 landings (153,263 pounds) (Table 2).

RIVER HERRING (BLUEBACK HERRING/ALEWIFE COMBINED):

Commercial landings of river herring declined 95% from over 13 million pounds in 1985 to about 700 thousand pounds in 2005. Recent commercial landings continue to increase, despite North Carolina restricting the commercial harvest of river herring in 2015. In 2016, river herring landings were reported from Maine, New York, Maryland, North Carolina and South Carolina. Landings in 2016 totaled 1,970,893 pounds, 2% less than 2015 landings of 2,005,154 pounds (Table 2).

Table 2. Shad and river herring in-river commercial and ocean bycatch landings (in pounds) provided by states, jurisdictions and NOAA Fisheries for 2016.

	American Shad	Hickory Shad	River Herring
Maine	^		*
New Hampshire			
Massachusetts			
Rhode Island			
Connecticut	32,620		
New York	^		*
New Jersey*	18,377		*
Pennsylvania			
Delaware	14,247		
Maryland	^		*
D.C.			
PRFC	1149		
Virginia	310	21	
North Carolina	62,244	96,543	
South Carolina	75,602	294	670,245
Georgia	34,228	3,221	
Florida			
Total	**239,067**	**100,079**	**1,970,893**

*Several state landings for river herring are not shown due to confidential data for Maine and Maryland
^American shad landings for Maine, New York and Maryland are confidential and not shown

IV. Status of Research and Monitoring

Under Amendment 2 (2009) and Amendment 3 (2010), fishery-independent and fishery-dependent monitoring programs became mandatory for select rivers. Juvenile abundance index (JAI) surveys, annual spawning stock surveys (Table 3), and hatchery evaluations are required for select states and jurisdictions. States are required to calculate mortality and/or survival

estimates, and monitor and report data relative to landings, catch, effort, and bycatch. States must submit annual reports including all monitoring and management program requirements, on or before July 1 of each year.

Table 3. American shad and river herring passage counts at select rivers along the Atlantic coast in 2016. This table includes the fish passage counts required by Amendments 2 and 3, it represents a sub-set the overall fish passage counts.

State/River	Shad	River Herring
Maine		
Androscoggin	1,096	114,874
Saco	16,926	22,644
Kennebec	830	224,990
Sebasticook	18	3,128,753
Penobscot	1,800	1,259,307
St. Croix		33,016
New Hampshire		
Cocheco		99,241
Exeter		6,622
Oyster		863
Lamprey		92,364
Taylor		
Winnicut		0
Massachusetts		
Merrimack	67,528	417,240
Rhode Island		
Gilbert Stuart		74,304
Nonquit		9,664
Buckeye Brook		27,552
Connecticut River		
Holyoke Dam	385,930	137
Pennsylvania/Maryland/Delaware		
Susquehanna (Conowingo)	14,276	34
Susquehanna (Holtwood)	6,718	
Susquehanna (Safe Harbor)	4,242	
Susquehanna (York Haven)	178	
South Carolina		
St. Stephen Dam	41,375	3,285
Total 2016	540,917	5,514,890
Total 2015	611,368	3,825,435
Total 2014	426,073	3,031,753
Total 2013	776,162	2,922,985
Total 2012	205,928	2,493,322

Note: Passage numbers on Susquehanna River are cumulative. For example, any shad counted at the York Haven dam has also passed the previous three dams (Safe Harbor, Holtwood and Conowingo). The dams are listed in ascending order of passage mile.

In addition to the mandatory monitoring requirements stipulated under Amendments 2 and 3, some states and jurisdictions continue important research initiatives for these species. For example, Massachusetts, Pennsylvania, Delaware, Maryland, District of Columbia, Virginia, North Carolina, South Carolina, and USFWS are actively involved in shad restoration using hatchery-cultured fry and fingerlings. All hatchery fish are marked with oxytetracycline marks on otoliths to allow future distinction from wild fish. During 2016, several jurisdictions reared American shad, stocking a total of **23,535,342 American shad, an increase of 9% from the** 21,519,800 shad stocked in 2015 (Table 4).

Table 4. Stocking of Hatchery-Cultured Alosines in State Waters, 2016.

State	American Shad	Alewife
Maine*		
Massachusetts		
Merrimack River	1,523,218	
Nashua River		
Charles River	2,059,799	
Rhode Island		
Pawcatuck River	1,072,252	
Pawtuxet River	1,053,167	
Pennsylvania		
Susquehanna River	1,746,873	
Lehigh River	236,062	
Schuykill River	261,940	
Maryland		
Choptank River	2,467,000	
District of Columbia		
Anacostia River	0**	
Virginia		
James River	1,879,628	
North Carolina		
Roanoke River	3,738,732	
Neuse River	609,720	
South Carolina		
Edisto River	16,494	
Santee River	4,387,007	
Georgia		
Altamaha River	1,720,127	
Ogeechee	763,323	
Total	**23,535,342**	**0**

*Maine: Only river herring are of wild origin are stocked as adult pre-spawning individuals on the Androscoggin, Kennebec and Union Rivers

**No American shad were stocked in 2016 so no samples were taken from juvenile American shad for the hatchery evaluation

V. Status of Management Measures

All state programs must implement commercial and recreational management measures or an alternative program approved by the Management Board (Table 1). The current status of each state's compliance with these measures is provided in the Shad and River Herring Plan Review Team Report (enclosed).

Shad and river herring are currently managed under Amendments 2 and 3. In 2009 the Board approved Amendment 2, which was initiated in response to concerns over river herring stock. The amendment prohibits commercial and recreational fisheries in state waters beginning January 1, 2012, unless a state or jurisdiction submits a sustainable fishery management plan and receives approval from the Board. Sustainable fishery management plans (SFMPs) have been approved by the Management Board for Maine, New Hampshire, Massachusetts, New York, North Carolina and South Carolina (Table 1).

In 2010, the Board approved Amendment 3, which was initiated in response to concerns over shad stocks. The Amendment requires similar management and monitoring as developed in Amendment 2, specifically the development of a SFMP for any jurisdiction that will maintain a commercial or recreational fishery after January 1, 2013 (with the exception of catch and release recreational fisheries). SFMPs have been approved by the Management Board for Florida, Georgia, South Carolina, North Carolina, the Potomac River Fisheries Commission (PRFC), Connecticut and the Delaware River Basin Cooperative (on behalf of New York, Delaware, New Jersey, and Pennsylvania) (Table 1).

States are required to update their SFMP every five years. In 2017, states reviewed their current SFMPs and, made changes based on fishery performance or observations (e.g., revise the sustainability targets) where necessary. At minimum, states updated the data for their commercial and/or recreational fisheries and recommended the current sustainability measures be carried forward in the next plan. The Technical Committee will review all SFMPs and make recommends to the Board. States have presented SFMPs to the Board according to the following timeline:

2017 SFMP Timeline

February Board Meeting

- Maine (RH)
- Delaware River Basin Cooperative (Shad)
- New York (RH)

August Board Meeting

- South Carolina (RH)
- Florida (shad)

October Board Meeting

- South Carolina (shad)
- PRFC (shad)
- Georgia (shad)

- North Carolina (shad)
- Connecticut (shad)

V. Prioritized Research Needs

Fishery-Dependent Priorities

High

- Expand observer and port sampling coverage to quantify additional sources of mortality for alosine species, including bait fisheries, as well as rates of bycatch in other fisheries to reduce uncertainty.[2]

Moderate

- Identify directed harvest and bycatch losses of American shad in ocean and bay waters of Atlantic Maritime Canada.

Low

- Identify additional sources of historical catch data of the US small pelagic fisheries to better represent earlier harvest of river herring and improve model formulation.

Fishery-Independent Priorities

Moderate

- Develop demersal and pelagic trawl CPUE indices of offshore river herring biomass.

Modeling / Quantitative Priorities

High

- Conduct population assessments on river herring, particularly in the south.[3]
- Analyze the consequences of interactions between the offshore bycatch fisheries and population trends in the rivers.
- Quantify fishing mortality for major river stocks after ocean closure of directed fisheries (river, ocean bycatch, bait fisheries).
- Improve methods to develop biological benchmarks used in assessment modeling (fecundity-at-age, sex specific mean weight-at-age, partial recruitment vector/maturity schedules) for river herring and American shad of both semelparous and iteroparous stocks.
- Improve methods for calculating M.

Moderate

- Consider standardization of indices with a GLM to improve trend estimates and uncertainty characterization.
- Explore peer-reviewed stock assessment models for use in additional river systems as more data become available.

[2] A prior statistical study of observer allocation and coverage should be conducted (see Hanke et al. 2012).

[3] A peer reviewed river herring stock assessment was completed in 2012 by the ASMFC.

Low

- Develop models to predict the potential impacts of climate change on river herring distribution and stock persistence.

Life History, Biological, and Habitat Priorities

High

- Conduct studies to quantify and improve fish passage efficiency and support the implementation of standard practices.
- Assess the efficiency of using hydroacoustics to repel alosines or pheromones to attract alosines to fish passage structures. Test commercially available acoustic equipment at existing fish passage facilities. Develop methods to isolate/manufacture pheromones or other alosine attractants.
- Investigate the relationship between juvenile river herring/American shad and subsequent year class strength, with emphasis on the validity of juvenile abundance indices, rates and sources of immature mortality, migratory behavior of juveniles, and life history requirements.
- Develop an integrated coastal remote telemetry system or network that would allow tagged fish to be tracked throughout their coastal migration and into the estuarine and riverine environments. UPDATE: currently available for American shad but not in use due to tagging mortality
- Continue studies to determine river herring population stock structure along the coast and enable determination of river origin of catch in mixed stock fisheries and incidental catch in non-targeted ocean fisheries. Spatially delineate mixed stock and Delaware stock areas within the Delaware system. Methods to be considered could include otolith microchemistry, oxytetracycline otolith marking, genetic analysis, and/or tagging.[4]
- Validate the different values of M for river herring and American shad stocks through shad ageing techniques and repeat spawning information.
- Continue to assess current ageing techniques for river herring and American shad, using known-age fish, scales, otoliths, and spawning marks. Conduct biannual ageing workshops to maintain consistency and accuracy of ageing fish sampled in state programs.[5]
- Summarize existing information on predation by striped bass and other species. Quantify consumption through modeling (e.g., MSVPA), diet, and bioenergetics studies.
- Refine techniques for tank spawning of American shad. Secure adequate eggs for culture programs using native broodstock.

Moderate

- Determine the effects of passage barriers on all life history stages of American shad and river herring. Conduct studies on turbine mortality, migration delay, downstream passage, and sub-lethal effects. UPDATE: Recent studies have been conducted by T. Castro-Santos of UMass.
- Evaluate and ultimately validate large-scale hydroacoustic methods to quantify river herring and American shad escapement in major river systems.
- Conduct studies of egg and larval survival and development.

[4] Genetic research currently underway in combination with otolith chemistry.

[5] River herring ageing workshop occurred in 2013.

- Conduct studies on energetics of feeding and spawning migrations of American shad on the Atlantic coast.
- Resource management agencies in each state shall evaluate their respective state water quality standards and criteria and identify hard limits to ensure that those standards, criteria, and limits account for the special needs of alosines. Primary emphasis should be on locations where sensitive egg and larval stages are found.
- Encourage university research on hickory shad.
- Develop better fish culture techniques, marking techniques, and supplemental stocking strategies for river herring.

Low

- Characterize tributary habitat quality and quantity for Alosine reintroductions and fish passage development.
- States should identify and quantify potential shad and river herring spawning and nursery habitat not presently utilized, including a list of areas that would support such habitat if water quality and access were improved or created, and analyze the cost of recovery within those areas. States may wish to identify areas targeted for restoration as essential habitat.[11]
- Investigate contribution of landlocked versus anadromous produced river herring.

VII. PRT Recommendations

State Compliance

All states with a declared interest in the management of shad and river herring have submitted reports and have regulations in place that meet the requirements of the Interstate Fisheries Management Plan for Shad and River Herring.

The PRT notes, however, that some states were not able to complete the required fishery independent monitoring due to budgetary restrictions.

1. Several of the states did not report all of the monitoring requirements listed under Amendments 2 and 3 (see PRT Report). The states should take note of the required monitoring programs that were not reported and make concerted effort to report all monitoring programs in forthcoming annual reports (most common omissions were: characterization of other losses, variance, characterization of recreational harvest, length and age frequency, and degree of repeat spawning).

2. The PRT requests that those states and jurisdictions that share monitoring should report who was responsible for the required monitoring in lieu of not including the information. In addition, one report could be sent for each state or jurisdiction.

De Minimis Status

A state can request *de minimis* status if commercial landings of river herring or shad are less than 1% of the coastwide commercial total. *De minimis* status exempts the state from the sub-sampling requirements for commercial and recreational catch for biological data. The following states have met the requirements and requested continued *de minimis* status in 2016:

- Maine (American *shad*)
- New Hampshire (American shad and river herring)
- Massachusetts (American shad)
- Florida (American shad and river herring)

The PRT would like clarification on recreational fishery monitoring requirements for shad and river herring. In January 2007, the Management Board suspended the requirement to monitor the recreational fishery until the stock assessment had been completed and a template for creel surveys had been developed. The stock assessment was completed, but a creel survey template was not finalized, so the requirement was not reinstated. In 2009 and 2010 Amendments 2 and 3, respectively, were approved by the Management Board, which outline recreational monitoring requirements coastwide, but still do not provide a template for creel surveys. Many states are not currently monitoring recreational fisheries as MRFSS/MRIP data are no longer provided for these species, many states do not have the funding and staff to complete these surveys, and surveys in the past have revealed that recreational harvest is relatively low compared to the coastwide commercial harvest. The PRT would like clarification if it is the intent of Amendments 2 and 3 to re-instate recreational fishery monitoring coastwide and if so should a creel survey template be developed by the Technical Committee.

PRT REVIEW OF SHAD AND RIVER HERRING ANNUAL COMPLIANCE REPORTS

INTRODUCTION

In accordance with the Shad and River Herring Fishery Management Plan, the states are required to submit an annual compliance report by July 1st of each year. The Plan Review Team reviewed all state reports for compliance with the mandatory measures in Amendments 2 (River Herring) and 3 (American shad). The following report provides an evaluation of each state program.

MAINE

De minimis

- The state of Maine requests *de minimis* for the commercial fishing year 2016 in the American shad fishery.

Comments or trends highlighted in state report:

- American shad recreational catch estimates = 8,870 fish caught (A+B1+B2) and 1,740 harvested (A+B1) (MRIP).
- Comparing the juvenile CPUE to past years, American shad CPUE was below average in all river segments except the Cathanee and Eastern Rivers.
- Comparing the JAI CPUE to past years, 2016 had the highest alewife CPUE on record for the lower Kennebec River. The Eastern River CPUE was the 2nd highest in 35 years. Juvenile alewife CPUE was below average for 4 of 7 river segments. Blueback CPUE were 2nd highest in upper river.
- There was a strong alewife run in the Kennebec River drainage in 2016.
- Spawning Stock Survey: In 2016, fisheries personnel counted and passed upstream 830 American shad in the trap at the Lockwood Dam on the Kennebec River, and 18 at the Benton Falls fish lift on the Sebasticook River. At the Brunswick Fishway on the

Androscoggin River, 1,096 American shad were captured in the fish lift. On the Saco River, Brookfield Energy biologists counted a total of 16,462 American shad (13,889 passing the East Channel Dam, and 2,573 passing the West Channel Dam). Additionally, 442 shad mortalities were noted, representing a total fishway mortality of 3.2%, which is higher compared to 2015.

Unreported information / Compliance Issues:

- Shad Fishery independent monitoring: no variance was mentioned for juvenile indices.
- River herring scale samples collected from commercial harvesters are being processed.

Sturgeon bycatch report:

- There was no known bycatch of Atlantic or shortnose sturgeon within the recreational fishery.

NEW HAMPSHIRE

***De minimis*:**

- The state of New Hampshire requests *de minimis* status for the commercial and recreational fishing year 2016 for the American shad and river herring fisheries.

Comments or trends highlighted in state report:

- No American shad were harvested from New Hampshire waters in 2016.
- Since 2006, a total of 11 American shad have been observed in the Exeter River.
- River herring SFMP target met for 2016 – exploitation rate <20% (4.4%) and returns >72,293 fish (199,090 fish).
- In 2016, 4,354 lbs of river herring were reported harvested from New Hampshire waters through mandatory coastal harvest reports. It is noted that this harvest is for personal use and is no longer included with NMFS harvest.
- Recreational harvest estimates for river herring were 840 alewives and 0 blueback herring in NH through the Access-Point Angler Intercept Survey (APAIS).
- There is a general increase in alewife herring runs in New Hampshire waters for the last 7 years.
- Geometric mean for juvenile alewives was lower in 2016 than 2015, but still higher than the means encountered between 2009 and 2012.

Unreported information / Compliance Issues:

- None identified.

Sturgeon bycatch report:

- No protected species were reported taken as bycatch from New Hampshire's coastal harvest program.

MASSACHUSETTS

***De minimis*:**

- The Commonwealth of Massachusetts requests *de minimis* for the commercial fishing year 2016 for the American shad fishery.

Comments or trends highlighted in state report:

- 0 pounds of American shad were reported landed from Massachusetts by NMFS Statistic and Economic Division.
- Merrimack River American shad counts have shown a general increase since 2010; a total of 67,528 American shad passed Essex Dam in 2016.
- Connecticut River Holyoke Dam American shad counts have seen a general increase since 2004, and appear to be relatively stable since 2012 recording greater than 300,000 American shad annually.
- An exploratory study was initiated by the Massachusetts Division of Marine Fisheries to monitor the presence and abundance of American shad in the South and Indianhead rivers.
- Since 2006, analyses indicate an increasing trend in river herring run sizes in most monitored rivers with a time series high observed in the Merrimack River in 2016.

Unreported information / Compliance Issues:

- Catch composition data was not available for the American shad recreational fishery in the Merrimack River.
- A juvenile abundance index was not reported for the Merrimack River American shad.
- A description of Amendment 2 and 3 requirements for river herring and shad should be included in the compliance report; it is unclear what the recreational fishery monitoring requirements are.
- Degree of repeat spawning was not evaluated in the river herring spawning stock surveys.
- Age and length composition from bycatch sampling was not reported.

Sturgeon bycatch report:

- No sturgeon interactions were reported in 2016.

RHODE ISLAND

Comments or trends highlighted in state report:

- No significant changes in monitoring, regulations, or harvest in 2016.
- A total of 169 American Shad passed through the fishway in 2016.
- In 2016, 1,072,252 American shad fry were stocked in the Pawcatuck River and 1,053,167 into the Pawtuxet River.
- River herring run counts in 2016 were; Gilbert Stuart (74,304), Nonquit (9,664), and Buckeye Brook (27,552). Gilbert Stuart and Buckeye were higher than 2015, but Nonquit had lowest return in 15+ years.

Unreported information / Compliance Issues:

- None

Sturgeon bycatch report:

- One Atlantic sturgeon was observed by the NOAA Fisheries Observer Program in 2015.

CONNECTICUT

Comments or trends highlighted in state report:

- The preliminary 2015 landings are 51,004 pounds (14,637 fish) of American shad from drift gillnets through harvester catch reporting.
- Shad spawning population relies on a few age classes and low rates of repeat spawners.
- Passage of 412,656 shad at Holyoke was third highest since 1992.

Unreported information / Compliance Issues:

- Estimate of other commercial losses is reported by weight instead of length and age.
- Directed recreational harvest of shad is not characterized due to limited budget and staff.
- No sources of river herring loss are listed.
- No age frequency, degree of repeat spawning, or annual mortality rate calculation is provided for river herring.

Sturgeon bycatch report:

- A total of 37 sturgeons (species unclassified) were reported as caught and released by shad fishermen in 2015.

NEW YORK

Comments and trends highlighted in state report:

- In 2016 no changes to in-river fishery, recreational or commercial regulations, or fishery independent sampling.
- Commercial and recreational shad fishery closed in 2010.
- In 2016 the fisheries unit refocused efforts on aging shad scales, age-length key was used between 2003-2015.
- Mandatory reporting of river herring harvest = 6,791 pounds landed in Hudson River.
- Shad landings were reported through ACCSP, however due to confidentiality agreements, this data cannot be disclosed.
- 2016 American shad spawning stock survey sex ratio was 66:34 (male:female)
- 2016 river herring spawning stock survey sex ratio: 70:30 (male:female) alewife and 26:74 (male:female) blueback herring.
- The 2016 index for YOY American Shad was 1.54. 2016 marks the second consecutive year below the recruitment failure limit. The 2016 index of YOY blueback herring continues a slightly declining trend while the Hudson Alewife index continues to generally increase.

Unreported Information / Compliance Issues:

- No data for commercial or recreational “other loss” of river herring is available.
- A river herring recreational creel survey was not conducted in 2016.

Sturgeon bycatch report:

- Sturgeon bycatch was not mentioned in 2016 report, though shad fishery remains closed.

NEW JERSEY

Comments and trends highlighted in state report:

- Coastal commercial shad fishery closed in 2016.
- Directed ocean shad fishery closed in 2005.

- NMFS landings of shad unavailable for 2016, but was 0 in 2015.
- The NJ Ocean Trawl Survey had a geometric mean CPUE of shad in 2016 of 1.72, ranking first in the 28 year time series.
- During 2016 NJ commercial fishers reported harvest of 4 lbs. of river herring.
- Ocean Trawl Survey for both alewives and blueback herring had sharp decline in geometric mean beginning in 2010, but now starting to increase.

Unreported Information / Compliance Issues:

- No fishery independent monitoring in 2016 for shad or river herring.
- No recreational fishery data for river herring.
- No state regulations listed.
- No sex or age data for shad or river herring. Length data from Ocean Trawl Survey only.

Sturgeon bycatch report:

- No sturgeon was reported as bycatch in 2016 coastal fishery due to the required closure in coastal waters.

PENNSYLVANIA

Comments or trends highlighted in state report:

- No commercial or recreational harvest of American Shad is permitted within the Susquehanna River basin. Commercial harvest of hickory shad, alewife and blueback herring is prohibited in any state water.
- Recreational harvest of river herring was prohibited in 2016.
- In general, the 2016 American shad spawning stock showed a 1:0.5 (M:F) sex ratio, a decrease in mean total length and mean total weight, a slight decrease in mean age, and an increase in the frequency of repeat spawning.
- 89% of recovered juvenile American Shad in 2016 were found to be of hatchery origin.
- No juvenile Hickory Shad, Blueback Herring or Alewife were collected in haul seine efforts from 2002 to 2016.

Unreported Information / Compliance Issues:

- None.

Sturgeon bycatch report:

- No sturgeon have been reported using the fish passage structures on the Susquehanna River.

DELAWARE – NANTICOKE RIVER

Comments or trends highlighted in state report:

- Thirty-three juvenile American Shad were collected in the Nanticoke River which was slightly lower than the 2015 JAI.
- The 2016 electrofishing American Shad CPUE increased noticeably from 2015 and ranked seventh lowest in the time series.
- Most shad restoration efforts throughout the Northeast United States rely on stocking programs to supplement natural reproduction and accelerate the recovery process. An

estimated 437,000 American Shad fry were stocked in Nanticoke River tributaries during the spring of 2016.

- The Blueback Herring JAI decreased from 2015 to the sixth lowest value in the time series. Alewife abundance decreased from its 2015 value to the ninth lowest value in the time series.

Unreported information / Compliance Issues:

- None.

Sturgeon bycatch report:

- There have been no voluntary or anecdotal reports of Atlantic Sturgeon or other protected species caught in the Nanticoke River commercial gill net fishery.

DELAWARE BASIN F&W COOPERATIVE

Comments or trends highlighted in state report:

- Commercial landings of American Shad in the Delaware Estuary and Bay as reported to New Jersey in their directed fishery (18,377 pounds) were slightly below the time series average of ~25,000 pounds.
- Landings of American Shad reported to Delaware declined in 2016 (14,247 pounds) compared to 2015 (21,733 pounds).
- The Smithfield Beach CPUE was suggestive of a below average spawning run of American shad in the Delaware River in 2016
- Review of the identified four indices and their respective benchmarks in the American Shad Sustainable Fishing Plan indicate two of the four indices were well within acceptable levels.
- Juvenile abundance indices from New Jersey's upper tidal beach seine survey shows a serious decline in the overall health of the Blueback Herring stock within the river. Alewife recruitment for 2016 was also below the time series average.
- Adult river herring catch rates increased from 2015, but are highly variable between years.

Unreported information / Compliance Issues:

- Age and repeat spawning composition data from the commercial fishery were not reported for 2016. The Co-op members have been working on developing standardized ageing protocols specific to the Delaware River Basin. Once finalized, age and repeat spawning frequencies will be determined from commercial landing samples.
- No recreational angler use or harvest information is available for 2016.

Sturgeon bycatch report:

- According to commercial reports collected from New Jersey commercial shad fishers there were six Atlantic Sturgeon caught as bycatch during 2016 in Delaware Bay.
- In the Delaware River above the head of tide and the Lehigh and Schuylkill rivers, no sturgeon (Atlantic Sturgeon or Shortnose Sturgeon) have been reported caught.
- No sturgeon (Atlantic and Shortnose) have been observed using the fish passage structures on the Lehigh and Schuylkill rivers.

MARYLAND

Comments or trends highlighted in state report:

- American shad and river herring commercial fishery is closed; catch and release only.
- Relative abundance of American shad in Nanticoke and Potomac rivers has significantly increased over time series.
- No significant changes in American shad management in 2016.
- Total recreational release mortality is estimated to be 144 American shad per year (estimate based on two studies, one from 1997 and one from 2010).
- American shad JAI Decreased bay wide in 2016.
- Total loss of American shad from turbine mortality is somewhere between 3,241-8,589 for 2016.
- American Shad Stocking continues in Choptank River.
- In 2016, the Conowingo Dam tailrace American shad population was estimated at 153,171.
- Shad JAI for Upper Chesapeake Bay and Potomac River have increased linearly since 1980 while Nanticoke River has shown no trend.
- River herring relative abundance in Nanticoke River has declined over time series. River herring abundance declined in North East River in 2016.
- In 2016, The JAI CPUE for alewife and blueback herring both decreased in both the Upper Bay and the Nanticoke River.

Unreported / Compliance Issues:

- Spawning stock assessment for river herring began with 2013 gillnet survey for adult river herring in the North East River. Longer time series needed for this assessment.
- No characterization of other losses in commercial fishery due to lack of bycatch monitoring, funding, and staffing constraints.

Sturgeon bycatch report:

- The Atlantic sturgeon bycatch for Maryland's American shad ocean intercept fishery has been zero since this fishery was closed in 2005.

DISTRICT OF COLUMBIA

Comments or trends highlighted in state report:

- Commercial and recreational fisheries for river herring and shad remained closed.
- American shad fry stocking did not occur in 2016.
- In 2016, the American shad CPUE (fish per 6,000 square foot of net) increased to 2.78 compared to 2.04 in 2015.

Unreported information / Compliance Issues:

- DOEE has no direct estimate of any other losses occurring in any of the shad and river herring fisheries in the District of Columbia.
- No ageing has been done for American shad or river herring, thus age frequency, degree of repeat spawning and mortality estimates have not been reported.

Sturgeon bycatch report:

- No sturgeon captures were reported in the District of Columbia during 2016.

POTOMAC RIVER FISHERIES COMMISSION

Comments or trends highlighted in state report:

- Since 2012, all fisheries are closed to the taking and/or possession of river herring.
- The Potomac River is closed to the directed harvest, commercial and recreational, of American and hickory shad.
- Bycatch landings in 2016 included 1,149 pounds of American shad and no hickory shad.
- In 2016, the American shad restoration target (31.1) was exceeded for the sixth year in a row with a value of (43.3)
- The 2016 JAI index for American shad (3.84) greatly decreased from the time series high in 2015 (19.81), and the alewife and blueback herring indices (0 and 0.17, respectively) both decreased.

Unreported information / Compliance Issues:

- Variances for juvenile indices are missing.

Sturgeon bycatch report:

- In 2016, two Atlantic sturgeon captures were reported in the Potomac River. Both were released alive.

VIRGINIA

Comments or trends highlighted in state report:

- 93 American shad (310lbs) were taken under the 10 American shad per vessel per day bycatch allowance, which is less than the total adult American shad taken for research and monitoring.
- The number of trips taken by bycatch permit holders has declined the last two years.
- Juvenile abundance for American shad was lower in 2016 for all rivers compared to 2015 values, but remained relatively high in the Rappahannock River.
- The 2016 American shad spawning stock catch index was the lowest on record for the James and York Rivers.
- The overall assessment of the James River American shad population is that the stock remains at historically low levels and is dependent on hatchery inputs.
- In 2016, river herring fishery remained closed to both commercial and recreational harvest and possession.
- As of 2016, annual spawning stock surveys and representative sampling of river herring are occurring in all required Virginia systems.

Unreported information / Compliance Issues:

- Age and length composition was not reported for river herring bycatch monitoring from pound nets in the upper western Chesapeake Bay scientific permit collections.
- Degree of repeat spawning was not evaluated in the river herring spawning stock surveys.

Sturgeon bycatch report:

- In 2016, a total of two Atlantic sturgeon were caught as bycatch and released alive (James River, n=2; York River, n=0; Rappahannock River, n=0).

NORTH CAROLINA

Comments and trends highlighted in state report:

- In 2015, American shad landings totaled 62,244 pounds and were approximately 35% lower than 2015 due to various factors including weather and fish availability during the shortened season and represented the lowest harvest since the implementation of the SFP in 2013.
- The 2016 JAI for blueback herring (0.00) was below 2015 and the only year in the time series where no blueback herring were caught. The alewife JAI (0.38) was below 2015 (7.13) and also the time series average (~2.50).
- A total of 588 (184 aged) blueback herring and 997 (210 aged) alewife samples were obtained from four contracted Chowan River pound net fishermen.
- A total of 96,543 pounds of hickory shad were harvested in 2016 worth $29,418 which was a 35% decrease in the pounds landed as compared to 2015.

Unreported information / Compliance Issues:

Due to staff turnover and vacancy of the river herring biologist position, 2015 ageing analysis of blueback herring and alewife are incomplete. Ages will be included in the 2016 report or provided to the ASMFC as an appendix to this report, whichever comes first.

Sturgeon bycatch report:

- In 2016, 26 Atlantic sturgeon were observed or reported from the Albemarle Sound: four via the DMF observer data (released alive), and 22 via the DMF IGNS (1 fatality).
- Four Atlantic sturgeon were reported captured via onboard observers within the Pamlico Sound, Pamlico, Neuse and Cape Fear River Areas. One shortnose sturgeon was recorded during this reporting period in the Cape Fear River.
- In the Cape Fear River, DMF observer data recorded four Atlantic sturgeon interactions (three released alive, one dead). The DMF IGNS captured one Atlantic sturgeon which was released alive.
- Observer trips completed in the Pamlico and Neuse rivers recorded no sturgeon interactions.
- The DMF IGNS in the Pamlico Sound, Pamlico, Pungo, and Neuse Rivers captured five Atlantic sturgeon, all released alive.

SOUTH CAROLINA

Comments and trends highlighted in state report:

- In 2016, total estimated commercial landings of American shad, as reported through NMFS, was 75,801 pounds (100% in-river).
- In 2016, observed sex ratios for American shad were not available for the Santee and Waccamaw River because only females were available. The high occurrence of females in these samples is most likely due to the marketability of females vs. males.
- In 2016, three year running average for blueback herring on the Santee Cooper was u = 0.036, which was below the sustainability benchmark of 0.050.
- In 2016, the three year running average for blueback herring on the Pee Dee River did not exceed the benchmark of 1,000 kg.

Unreported information / Compliance Issues:

- None.

Sturgeon bycatch report:

- Atlantics – 15 total from Carolina DPS.
- Shortnose – 8 total from the Santee River.

GEORGIA

Comments and trends highlighted in state report:

- In 2016, commercial American shad landings was 32,071 pounds on the Altamaha and 2,157 pounds on the Savannah River.
- A recreational fishery at 8 shad per day (combination of American and/or Hickory) exists only on Savannah and Ogeechee River.
- The population of American shad in the Altamaha River in 2016 was estimated at 221,775 shad, an 8% decrease from 2015.
- In the 2016 American shad electrofishing surveys, catch rates increase for both the Savannah and Ogeechee Rivers.
- American shad fry were stocked into Altamaha tributaries and the Ogeechee River.

Unreported information / Compliance Issues:

- Shad recreational harvest data was not reported for 2016.

Sturgeon bycatch report:

- Atlantic and shortnose sturgeon are caught in gill nets. In drift nets, essentially 100% of the sturgeon can be released unharmed. During 30 direct observations of monitoring adult shad in 2016, no sturgeon were captured in drift gill nets from the Altamaha River. Shad fishermen reported capturing 23 Atlantic and 16 shortnose sturgeon from the Altamaha River. Commercial fishermen reported no incidental catches of sturgeon on the Savannah River during the 2016 commercial shad season.

FLORIDA

Comments and trends highlighted in state report:

- No commercial fishery exists for shad or river herring.
- There is no recreational harvest of river herring.
- An access point creel total estimated shad catch was 492 fish in Mullet Creel area and 2,287 in Puzzle Lake Creel area.
- In 2016, 499 American shad and 85 blueback herring were caught during eighty electrofishing transects on the St. Johns River.

Unreported information / Compliance Issues:

- Include more detail on blueback herring (currently no CPUE, length or age data).

Sturgeon bycatch report:

- No netting is allowed for shad, so no sturgeon bycatch is expected.