Atlantic States Marine Fisheries Commission

Shad and River Herring Management Board

February 4, 2021
8:30 – 11:30 a.m.
Webinar

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 *(M. Armstrong)*	8:30 a.m.
2.	Board Consent • Approval of Agenda • Approval of Proceedings from August 2020	8:30 a.m.
3.	Public Comment	8:35 a.m.
4.	Consider Management Response to the 2020 Shad Benchmark Assessment and Peer Review *(M. Armstrong)* • Review Technical Committee Recommendations *(B. Neilan)* • Advisory Panel Report (*P. Lyons Gromen*)	8:45 a.m.
5.	Review Technical Committee Recommendations on Improvements to Amendments 2 and 3 *(B. Neilan)* **Possible Action**	9:30 a.m.
6.	Break	10:30 a.m.
7.	Consider Shad Habitat Plan Updates **Action** • Review Technical Committee Recommendations *(B. Neilan)*	10:45 a.m.
8.	Consider Fishery Management Plan Review and State Compliance for the 2019 Fishing Year (*C. Starks*) **Action**	11:10 a.m.
9.	Review and Populate Advisory Panel Membership *(T. Berger)* **Action**	11:25 a.m.
10.	Other Business/Adjourn	11:30 a.m.

This meeting will be held via webinar, click here for details.
Sustainable and Cooperative Management of Atlantic Coastal Fisheries

MEETING OVERVIEW

Shad and River Herring Management Board
February 4, 2021
8:30 a.m. – 11:30 a.m.
Webinar

Chair: Mike Armstrong (MA) Assumed Chairmanship: 10/19	Technical Committee Chair: Brian Neilan (NJ)	Law Enforcement Committee Representative: L.Furlong (PA)
Vice Chair: Justin Davis	Advisory Panel Chair: Pam Lyons Gromen	Previous Board Meeting: August 4, 2020
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 2020

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

4. Consider Management Response to the 2020 American Shad Benchmark Stock Assessment (8:45-9:30 a.m.)

Background

- The American Shad 2020 Benchmark Stock Assessment and Peer Review Report was accepted for management use in August 2020. The assessment found that American shad remain depleted on a coastwide basis, likely due to multiple factors, such as fishing mortality, inadequate fish passage at dams, predation, pollution, habitat degradation, and climate change.
- At the August 2020 meeting, the Board tasked the Technical Committee (TC) with identifying potential paths forward to improve shad stocks given the results of the stock assessment. The TC met several times in the fall of 2020 and early 2021 to develop recommendations to address the Board Task (**Briefing Materials**).
- The Advisory Panel met twice to consider the recommendations of the TC and provide additional input for Board consideration (**Supplemental Materials**).

Presentations

- Technical Committee Recommendations by B. Neilan
- Advisory Panel Report by P. Lyons Gromen

Board actions for consideration at this meeting

- Consider management response to the assessment and peer review

5. Review Technical Committee Recommendations on Improvements to Amendments 2 and 3 (9:30-10:30 a.m.) Possible Action

Background

- In October 2017 the TC identified several inconsistencies between state SFMPs and the requirements of Amendments 2 and 3. Subsequently, the Board tasked the TC to develop proposed improvements to the Amendments with regard to several items: 1) Management and monitoring of rivers with low abundance and harvest of shad and river herring; 2) Standardization of Sustainable Fishery Management Plan (SFMP) requirements; 3) Incorporation of stock assessment information into SFMPs and discussion on the timeline for renewing plans; 4) Clarification of *de minimis* requirements as they pertain to SFMPs; and 5) Review of the number of years of data required before developing a SFMP.
- The Technical Committee met a number of times throughout 2020 to develop and finalize a list of recommendations to address each of the focus areas identified in the Board task (**Briefing Materials**).

Presentations

- Technical Committee Recommendations on Improvements to Amendments 2 and 3 by B. Neilan

Board actions for consideration at this meeting

- Consider initiating a management action to address the TC recommendations

6. Break (10:30-10:45 p.m.)

7. Consider Shad Habitat Plan Updates (10:45-11:10 a.m.) Action

Background

- Amendment 3 to the Shad and River Herring FMP requires all states and jurisdictions to submit a habitat plan for American shad. A majority of the habitat plans were approved by the Board in February 2014, and it was anticipated that they would be updated every five years.
- The states began the process of reviewing their American shad habitat plans and making updates in 2020, however, many states encountered delays due to COVID-19. The states that have submitted updated habitat plans for Board consideration are: ME, NH, MD, NC SC, and GA (**Briefing Materials**). The remaining states will provide their updated plans to the TC for review before the next Board meeting.
- The TC reviewed and recommends approval of these updated plans.

Presentations

- Shad Habitat Plan Updates for Board Consideration by B. Neilan

Board actions for consideration at this meeting

- Consider approval of updated shad habitat plans

8. Consider Fishery Management Plan Review and State Compliance for the 2019 Fishing Year (11:10-11:25 a.m.) Action

Background

- State Compliance Reports were due on July 1, 2019
- 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 FMP Review for 2019 fishing year, state compliance reports, and *de minimis* requests

9. Review and Populate Advisory Panel Membership (11:25-11:30 a.m.) Action
Background • Two individuals have been nominated to the Shad and River Herring Advisory Panel: Dr. Ed Hale of University of Delaware Sea Grant, and Eric Roach, a recreational angler from New Hampshire (**Briefing Materials**).
Presentations • Nominations by T. Berger
Board Actions for Consideration at the Meeting • Approve Shad and River Herring Advisory Panel nominations

10. Other Business/Adjourn

Shad and River Herring 2021 TC Tasks

Activity level: Medium

Committee Overlap Score: Medium (Multi-species committees for this Board)

Committee Task List
• Development of recommendations related to Board task on improving shad stocks • Spring 2020: Updates to state Shad Habitat Plans • Annual state compliance reports due July 1
TC Members: Mike Brown (ME), Mike Dionne (NH), Brad Chase (MA), Patrick McGee (RI), Jacque Benway Roberts (CT), Wes Eakin (Vice Chair, NY), Brian Neilan (Chair, NJ), Josh Tryninewski (PA), Johnny Moore (DE), Rob Bourdon (MD), Ellen Cosby (PRFC), Joseph Swann (DC), Eric Hilton (VA), Holly White (NC), Jeremy McCargo (NC), Bill Post (SC), Jim Page (GA), Reid Hyle (FL), Ken Sprankle (USFWS), Ruth Hass-Castro (NOAA)
Shad SAS: Michael Bailey (Chair, USFWS), Ken Sprankle (TC Chair, USFWS-CT), Joey Ballenger (SC), Mike Bednarski (VA), Wes Eakin (NY), Kevin Sullivan (NH), Joe Zydlewski (USGS), Jacque Benway-Roberts (CT), Kiersten Curti (NOAA-Fisheries), Angela Giuliano (MD), Jason Boucher (DE)

DRAFT PROCEEDINGS OF THE

ATLANTIC STATES MARINE FISHERIES COMMISSION

SHAD AND RIVER HERRING MANAGEMENT BOARD

Webinar
August 4, 2020

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

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ATTENDANCE

Board Members

Megan Ware, ME, proxy for P. Keliher (AA)
Sen. David Miramant, ME (LA)
Cheri Patterson, NH (AA)
Ritchie White, NH (GA)
Dennis Abbott, NH, proxy for Sen. Watters (LA)
Mike Armstrong, MA, (Chair)
Raymond Kane, MA (GA)
Sarah Ferrara, MA, proxy for Rep. Peake (LA)
Phil Edwards, RI
Eric Reid, RI, proxy for Rep. Sosnowski (LA)
Justin Davis, CT (AA)
Bill Hyatt, CT (GA)
Robert LaFrance, CT, Governor Appointee proxy
Maureen Davidson, NY, proxy for J. Gilmore (AA)
Emerson Hasbrouck, NY (GA)
John McMurray, NY, proxy for Sen. Kaminsky (LA)
Joe Cimino, NJ (AA)
Heather Corbett, NJ, Administrative proxy
Tom Fote, NJ (GA)
Adam Nowalsky, NJ, Legislative proxy (Chair)
Kris Kuhn, PA, proxy for T. Schaeffer (AA)
Loren Lustig, PA (GA)
G. Warren Elliott, PA (LA)
John Clark, DE, proxy for D. Saveikis (AA)
Roy Miller, DE (GA)
Craig Pugh, DE, proxy for Rep. Carson (LA)
Lynn Fegley, MD, proxy for B. Anderson (AA)
Russell Dize, MD (GA)
Allison Colden, MD, proxy for Del. Stein (LA)
Pat Geer, VA, proxy for S. Bowman (AA)
Chris Batsavage, NC, proxy for S. Murphey (AA)
Mel Bell, SC, proxy for P. Maier
Malcolm Rhodes, SC (GA)
Ross Self, SC, proxy for Sen. Cromer (LA)
Doug Haymans, GA (AA)
Spud Woodward, GA (GA)
Jim Estes, FL, proxy for J. McCawley (AA)
Rep. Thad Altman, FL (LA)
Marty Gary, PRFC
Bryan King, DC
Dan Ryan, DC, proxy
Derek Orner, NMFS
Sherry White, US FWS

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

Ex-Officio Members

Ken Sprankle, Technical Committee Chair
Mike Bailey, Stock Assessment Subcommittee Chair
Pam Lyons Gromen, Advisory Panel Chair

Staff

Bob Beal
Toni Kerns
Caitlin Starks
Maya Drzewicki
Kristen Anstead
Max Appelman
Tina Berger
Pat Campfield
Lisa Havel
Chris Jacobs
Jeff Kipp
Sarah Murry
Kirby Rootes-Murdy
Mike Schmidtke
Geoff White

Guests

Fred Akers
Seth Amgott
Bill Anderson, MD (AA)
Pat Augustine, Coram, NY
Michael Auriemma, NJ DEP
Joey Ballenger, SC DNR
Carolyn Belcher, GA DNR
Peter Benoit, Ofc. of Sen. King, ME
Jacque Benway, CT DEP
Dave Bethoney, CFR Foundation
Alan Bianchi, NC DNR
Jason Boucher, DE DFW
Rob Bourdon, MD DNR
Jeff Brust, NJ DFW

Guests (continued)

Twyla Cheatwood, NOAA
Benson Chiles, Chiles Consulting
Doug Christel, NOAA
Jeremy Cox, *Bay Journal*
Sen. Ronnie Cromer, SC (LA)
Jim Cummins, ICPRB
Curtis Dalpra, ICPRB
Jeff Deem, Lorton, VA
Mari-Beth DeLucia. TNC
Lyndon DeSalvo, TNC
Wes Eakin, NYS DEC
Sheila Eyler, US FWS
Jared Flowers, GA DNR
Matt Gates, CT DEEP
Shaun Gehen, Gehan Law
Emily Gilbert, NOAA
Lewis Gillingham, VMRC
Angela Giuliano, MD DNR
Zoe Goozner, Pew Trusts
Zack Greenberg, Pew Trusts
Jon Hare, NOAA
Carol Hoffman, NYS DEC
Kyle Hoffman, SC DNR
George Jackman
Rusty Hudson
Desmond Kahn
Patrick Keliher, ME (AA)
Alexa Kretsch, VMRC
Phil Langley, Dameron, MD
Chip Lynch, NOAA
John Maniscalco, NYS DEC
Genine McClair, MD DNR
Jason McNamee, RI (AA)
Steve Meyers
Mike Millard, US FWS
Chris Moore, MAFMC
David Mussina
Brian Neilan, NJ DFW
Ken Neill, Yorktown, VA
George O'Donnell, MD DNR
Ian Park DE DFW
Nicholas Popoff, US FWS
Bill Post, SC DNR
Alexei Sharov, MD DNR
Melissa Smith, ME DNR
Gregory Sorg, SC DNR
David Stormer, DE DFW
Kevin Sullivan, NH F&G
John Sweka, US FWS
Helen Takada-Heumacher, FL FWS
Hannah Welch, UNE
Holly White, NC DENR
Chris Wright, NOAA

The Shad and River Herring Management Board of the Atlantic States Marine Fisheries Commission convened via webinar; Tuesday, August 4, 2020, and was called to order at 8:30 a.m. by Chairman Michael Armstrong.

CALL TO ORDER

CHAIRMAN MICHAEL ARMSTRONG: Good morning everyone. I would like to open the Atlantic States Shad and River Herring Management Board. I'm Mike Armstrong from the Commonwealth of Massachusetts, your Chair. We've got a few things to cover today, the main ones being the review of the benchmark shad assessment and considering state proposals to resolve inconsistencies.

APPROVAL OF AGENDA

CHAIRMAN ARMSTRONG: We have a decent length of time, so I think we can probably get through all this stuff without killing ourselves. But we'll move right along. You all have a copy of the agenda. Are there any changes, additions that anyone would like to see? Are there any hands, Toni?

MS. TONI KERNS: No hands.

CHAIRMAN ARMSTRONG: All right, seeing none, the agenda is approved by consensus.

APPROVAL OF PROCEEDINGS

CHAIRMAN ARMSTRONG: You have the proceedings from October, 2019, any revisions necessary?

MS. KERNS: I don't see any hands.

CHAIRMAN ARMSTRONG: Seeing none the proceedings are approved by consensus.

PUBLIC COMMENT

CHAIRMAN ARMSTRONG: At this point we will solicit public comment, and again as we always say, items that are not going to be discussed later, so things on the assessment or state proposals to resolve inconsistency are not what we want to hear right now. Does anybody have a public comment on something other than things on the agenda?

MS. KERNS: Just a reminder to the public, you need to raise your hand by pushing the hand button if you want to speak. If you're having trouble with that you could shoot us a question or a chat. Mike, I don't see any hands raised.

CONSIDER ACCEPTANCE OF THE 2020 SHAD BENCHMARK STOCK ASSESSMENT

CHAIRMAN ARMSTRONG: In that case, we'll forge on, which brings us to Consideration of the 2020 Shad Benchmark Stock Assessment. This is an actionable item. At the end of all this we will need to accept the assessment and the review for management purposes.

PRESENTATION OF THE STOCK ASSESSMENT REPORT

CHAIRMAN ARMSTRONG: The first is the Presentation of the Stock Assessment Report, and that is by Mike Bailey. Take it, Mike.

DR. MICHAEL BAILEY: This is Mike Bailey from the U.S. Fish and Wildlife Service. I served as the Chairman for the benchmark stock assessment. I have about a 20-minute presentation, so I'll get started. The 2020 American Shad Benchmark Stock Assessment, here is our favorite fish just to start off.

Just for a brief outline, we're going to go through the stock structure, talk about life history information, and some of the data we collected, the assessment methods and methodology, and then we'll talk about the stock status and the conclusions from this benchmark. Stock structure, we had about 104 unique rivers, stocks from river beds. Out of those about 23 systems we actually had information to start the assessment.

Each individual river was considered its own stock, because of natal homing and some genetic differences. We used three regional meta-populations to share life history information. The species has a cline of iteroparous versus semelparous, and we use that as part of the breakup. Otherwise, this was work based on genetic information.

We have the northern iteroparous population, which is north of the Hudson River up to the Canadian Border and beyond. We have a southern iteroparous population north of the Cape Fear River up to the Hudson River, and then a semelparous from the Cape Fear River down to Florida. All of those fish only spawn once and then die, as opposed to the iteroparous fish, which will spawn more than once.

We did use some coastwide meta-population analysis for mixed stock datasets, including coastwide trawl samples, and some other samples in which we simply don't know which stock those fish are coming from. I'll just show you a series of slides. These are actually slides of river systems we use in the habitat modeling sections.

All of the red dots are dams on those river systems. This is the northern iteroparous section, where we have data from the Merrymeeting Bay, Merrimack, and Pawcatuk in Connecticut. This includes most of the southern iteroparous populations, so fish that spawn more than once but less than north.

We have down from the Hudson, down to the Neuse River. From the Cape Fear River down to St. Johns River, we consider these all semelparous populations, in which they spawn once and then die after spawning. For a life history snapshot, we looked at growth. We used a Bayesian hierarchical von Bertalanffy growth model.

Again, when we didn't have great data in any particular river system itself, we were able to share within those three larger grouping sections that we just talked about. We shared within their metapopulations. We did look at climate, and looked at climate at sea to see how the changing temperatures at sea could change the maximum size and growth, according to some climate projections going out to 100 years.

For natural mortality we used the Then estimator, which is an update of Hoenig 1983, which was used in the previous stock assessment. That is looking at natural mortality based on the maximum age of any given population of fish. The maximum age was 13 for northern and southern iteroparous populations, and for the semelparous populations it was a maximum age of nine, both giving different natural mortalities. The maturity schedule, we looked at Ogives, which is how often fish are going to come back, and at what age they come back to the river. To get a better idea, we used a slightly different methodology there, looking at the number of virgin-spawners, so the first time the fish came back, and then used the natural mortality estimators to look at how often they would come back in the future.

We did not use looking at spawning checks, which was used in other assessments, because our spawning checks for American shad we didn't have a whole lot of faith that those were great checks of when fish actually came back. We had very little data from fish at sea, so with shad some rivers have good estimates of YOY, young of year, when they're still in the river.

But then you don't hear from them again until they come back to the ocean, or they come back to the river to spawn. We have some big gaps at sea, which we'll mention numerous times during the stock assessment. For data indices of abundance, we had 21 fisheries dependent surveys and 65 fisheries independent surveys.

Some of those surveys were young of year indices within river. We had several run-count indices, in which from either fish ladders or fish ways, and then we had a lot of CPUE, so catch per unit effort surveys. Just as an example, here is the Hudson River young of year survey, looking at larger populations back in the '80s and '90s to the points where we are today in which the index is significantly smaller.

We have some catch data, although with the closure of some fisheries we have a little bit less catch data than we've had in previous stock assessments. We have system-specific commercial data landings when possible. We have total mix commercial landings, both U.S. and Canada. The histogram on the right is

all reported U.S. Commercial landings, both riverine and ocean.

We have pretty limited recreational catch for the entire time series, so we don't know how to use that for much at all. The plot with the error bars is American shad total incidental catch and discard catch from the late '80s to 2017. Just a note on that. Midwater trawl fleets were included starting in about 2005.

Age compositions of fish, especially for shad comes up a lot. It's difficult to age shad. We have about 18 datasets representing 12 different systems, so we have several systems that have both scales and otoliths. Otoliths are generally better for determining age. You do have to sacrifice the fish to get those otoliths out.

Spawning check marks were imprecise, more imprecise than age data, and they were not used in the assessment for very much, except for some very minor issues. If you look at the figures, those are the CVs from comparing scale age estimates to known age fish. On the left in otolith estimates the known age fish on the right.

You can see the coefficient of variation for otoliths is much smaller. That more precise data gives us an idea that those otoliths are much more precise, and better to use. Some scale reading can be used, and it can get to a pretty tight coefficient of variation, although not all the time, certainly not as often as otolith ages. Habitat was something that we tried to tackle with this benchmark, to a higher degree than it had been done in the past. We looked at the riverine habitat area. This was based largely on expert opinion, and with GIF models looking at the idea of how big of a river shad are looking for.

What we did was we looked at historic habitat prior to barriers put in. We looked at currently unobstructed habitat, and then we ran kind of the pre-dam, post-dam, we ran some population models to look at some of the population size and estimates of fish that we don't have coming back because of the lack of habitat.

That is something that I think we've put a lot of work into for this benchmark, and it really took a lot of hands to lift that, so I appreciate showing some of the habitat work. That is kind of what we have for data for the assessment methods, how we went about it was we did multiple different things, one of which was looking to power analysis.

When I'm talking about that I'm talking about kind of the signal versus the noise. We were able to look at abundance datasets, and look at trends over time periods. Through that power analysis we were able to look at, hey will you be able to see a change if a change occurs, looking at kind of your baseline data you've been collecting, and the variation about that?

We were able to evaluate uncertainty, and provide a basis for improvement to monitoring programs. The big question there is, are you collecting good enough data that you'll actually be able to see if there is a change? Another thing we did was trend analysis. We used Mann-Kendall for detecting trends in abundance, mean lengths, and mean lengths at age.

We also used ARIMA models to compare recent abundance to reference abundance points. Those Mann-Kendall abundance trends time period at a certain start year and then moving forward, the ARIMA kind of our change of abundance set was 2005, 2005 was when the coastwide ocean intercept fishery was closed.

You'll see in the results we used 2005 as kind of that change point, to see when we expect to start seeing changes. The assessment methods, again we did a per recruit analysis. We used estimates of spawning potential under various total mortality levels, relative to baseline spawning potential, so kind of our baseline mortality there.

We provided reference points for total mortality, using a Z percent. Most of those data inputs there were life history information for any particular river. We selected Z40 as a threshold for American shad mortality. That total mortality results in 40 percent of

spawning stock biomass per recruit of natural mortality.

But Z40 is more conservative than the threshold used in previous assessments, which was Z30. The more conservative threshold is appropriate, given published simulation analysis. Really, a big part of that is the data poor characterization for many American shad stocks, and the uncertainty in the resilience of the species due to many different anthropomorphic impacts. I've used total mortality estimators catch curves, to get an idea of abundance, of mortality, I'm sorry. Estimates of total mortality were based on the decline of abundance across subsequent age classes. The data input for these models were mostly age compositions. We were able to compare the Z threshold reference points to determine mortality status. We used the last three years, so 2015, '16, and '17 of those Z estimates to compare, to see if we had sustainable or unsustainable mortality. This is an example of using the Hudson River spawning stock Haul Seine Electrofishing Surveys, to look at instantaneous mortality over time, to see if it's above or below that Z line.

We also use a delayed difference model, which is a biomass dynamics model that allows for a lag in recruitment to exploitable biomass. We had some extra help with having some experts on this model in the peer review, which helped us change this a bit from how we originally had it to post peer review, we got some better answers from using the delayed difference model.

Estimates of exploitation time series, so fishing and exploitation resulting in maximum sustainable yield, which is what we compared to. The inputs for this model were catch, index of abundance, and life history information, and again we applied the stocks with active fisheries to determine the mortality status from those last three years of data we used, the 2015, '16, and '17, to indicate mortality.

We were able to for the first time with shad, use a statistical catch at age model for two systems, the Albemarle Sound and the Potomac River. These were more advanced models that in the past we haven't had good enough data to use. It's a forward projecting population model that estimates recruitment, spawning stock biomass, and mortality.

It integrates the comprehensive suite of data, and can separate mortality from direct anthropomorphic stock removal. These removals can include fishery removal, and fisheries plus. In terms of the Potomac they also have a brood stock program, which removes (last word broke up). We were able to look at that as well.

The data inputs are, again this is a hungry model, it needs a lot of data. We used index of abundance, total catch at age composition, and life history information. This estimates the per recruit reference points internally, including the spawning stock biomass-based reference points for model estimate recruitments.

Again, we're using that Z40 to look at if it's sustainable mortality, and looking at the spawning stock biomass indicate that it's a depleted stock or an overfished stock. That was just a quick background. I will say this is a large document, and there is a lot of information in it. I'm just trying to touch on some of the highlights.

Looking at the results, the power analysis is signal versus noise assessment. This is going to be an important tool for fisheries managers to allow for future planning and sampling. Folks will be able to look at that and see if there are current samplings, with the current variability about that sampling is going to actually allow them to see if there is a change, in which we've set some of the change, what we're looking for in the model.

This is something that I think a lot of folks are going to go back after looking at this, and decide hey, are we sampling correctly? Do we need to augment our sampling? Do we need to do more? Do we need to do less? That is something we're happy that's going to be a tool for fisheries managers to use. You know our abundance trend, again the power analysis, about 57 to 65 indices were unable to detect trends over 10 years if the threshold would be set. Again, this is an opportunity to reevaluate. Are you going to be able to

see trends with your current data collection systems, and how should you change those?

Some of the adult trends, since 2005 we had 4 increasing trends, 0 decreasing trends. This is from the Mann-Kendall. Eleven with no trends, and 7 with conflicting trends, so a lot of variation since that 2005 benchmark kind of threshold we set to look at changes over time. The young of year indexes, again pretty mixed up and down trends.

Most of them with no trends, or datasets that don't have enough data to give us a trend. There is no consistent response in coastwide metapopulation abundance after that ocean intercept fisheries were closed in 2005. We were able to get some abundance status trends as well. The Hudson stock is depleted, so this is a qualitative determination for the Hudson, and a coastwide metapopulation based on historical landings, and indices of abundance.

When we had historic lands and indices of abundance, we felt like we could get the status of an individual river system. The Albemarle Sound determination was based on comparison of projected per recruit reference points and model estimator's recruitment. That was not overfished.

One thing to note is only adult mortality levels could be determined from the available data. We don't have young of year indices in any of our rivers to get good enough ideas of juvenile mortality. Three stocks are experiencing unsustainable adult mortality, those are the Connecticut, the Delaware, and the Potomac.

All three of these stocks are managed according to management programs, sustainable fisheries plans. Five stocks are experiencing sustainable adult mortality. The Hudson you'll notice, we've already talked about it as depleted. Although they're having sustainable adult mortality, they're under recruitment failure. I just wanted to mention that, a little misleading there.

A bunch of these rivers are under sustainable fisheries management plans, the James, York, and Rappahannock are under a bycatch plan. One thing we did note here when it comes to mortality status, is although we have three stocks that are experiencing unsustainable adult mortality, that is not necessarily fishing mortality.

That may be under other types of mortality, not simply F, but the other is anthropometric adult mortality that is probably featuring into those factors. For habitat assessment and simulation modeling, this is what I mentioned before in some of the methodology. We were able to get expert opinion and GIS modeling, get into a situation in which we can look at the first set up there is spawning runs with Habitats 1, Habitat 2, Habitat 3.

Those are just different units in an undammed river, and we have population models that can look at that scenario of all the river being opened. The next setup there is a dammed river, in which there is no passage at all. We can look at the habitat section that has no dams on it, and no increased mortality from upstream or downstream mortality at this dam. Then we have our current set up, which is the third scenario here, in which we have Habitat 1, before a dam. We have an idea of how many fish can be there, and then we model looking at pretty positive passageways to look at how those fish move up and down.

That is kind of our current state modeled throughout the coast, to get an idea of how many fish come up and down there. With that habitat assessment simulation modeling, the current is modeled with very optimistic upstream and downstream passage. At the rate of about 50 percent upstream passage per dam of all the dams, 80 percent passage downstream to adult, and then juveniles have a 90 percent survival as well.

Those are optimistic from a lot of the empirical datasets out there. The simulation analysis showed habitat restrictions are a major impediment to spawning potential, and that optimistic passage scenarios only offer modest gains in spawning potential. With those, the current setup we still have very limited and reduced spawning potential.

The dams that there is optimistic passage only gives about a 4 percent increase in the spawning potential. I know this is very small, but maybe some of you can point out your favorite river here, and we can see some of these. The black bars are the current available area downstream of the first dam, and the white bars are the total potential for the river, and that is based on our GIS estimate of habitat to look at.

The historic habitat prior to anthropomorphic barriers is certainly much higher. Currently there is a lot of rivers with a lot of obstructed habitat. Now 45 percent of the historic habitat is currently obstructed. Again, this was a lot of work put in by expert opinions on some good modelers that really gave us the first step back look at habitat for a lot of this on a coastwide basis.

You can see some of those white bars are quite large, meaning that there is a lot of habitat that is no longer available for shad. The conclusions, habitat loss due to barriers are likely restricting positive response in the coastwide metapopulation abundance. We have poorly characterized additive mortality because of dams.

We have many situations in which as a group we were debating looking at fishing mortality, and saying how much of this is fishing versus how much of this is habitat and dam related. Our Fs and our Zs started to blend together, which was difficult, and we talked about quite a bit in the assessment.

Habitat access is leading to a reduction of ability. Fish could be harvested either commercially or recreationally. I think habitat is the key to this benchmark stock assessment. Adult mortality was determined to be unsustainable for some system-specific stocks, indicating continued need for action to reduce adult mortality.

We need to have the ability to decouple fishing; recreational, commercial, and bycatch in other anthropomorphic causes. Juvenile mortality during the life stage in the ocean between leaving the river and coming back mature adults is simply unknown. Even in cases where adult mortality is determined to be sustainable, overall stock sustainability can be compromised if juvenile mortality is too low. We still have a black box at sea out there, that we don't have a good idea of all the juvenile fish, and the fish that have already spawned once and go back out to sea that just don't do that.

The assessment doesn't rule out bycatch impacts on stock response, but it does provide a definitive link between stock trends and bycatch level, at which again there is a lot of uncertainty in that bycatch in fact. Looking forward, that unknown juvenile mortality is still a major limitation that we need a lot more information about.

There is almost no information collected as I mentioned on those juvenile fish. Another aspect of stocks at sea are mixing, and we don't have a good idea on if we do sample juveniles at sea, to understand which stock they're coming from. That stock composition data is essential to improving assessment of American shad.

We now have since the last stock assessment moving forward, we have much better genetic baselines that will allow for some of those juvenile samples collected at sea to be brought back to a natal river, with a lot of work that could be done. That is something that before the last stock assessment it was impossible, but now we're moving up to that phase.

The Stock Assessment Subcommittee just kind of wanted to throw some names out there. I could point to everyone and say what they've done, but that would take up a good chunk of the day. It was a pretty dedicated group that did a lot of work for this benchmark, and I'm pretty happy with the results.

Certainly, all the Tech Committee and some people came in and came out over the time period. I'm sure I left some people out. But this is kind of other folks to thank as well. One thing that we did reach out and ask for some short timelines on was that expert opinion on habitat modeling, so we appreciate that.

We were also able to get some information on Canadian stocks, which we previously hadn't gotten to the great got. Those were some great things moving forward. Again, ASMFC staff did a lot of work on preparing the actual report. Those large documents are nothing fun to wrestle with, and we appreciate that quite a bit. That concludes this for the big overview of the shad benchmark.

CHAIRMAN ARMSTRONG: Thank you, Dr. Bailey. I think what we're going to do at this point is forego questions, and hear the Peer Review Report first. But before doing that I would like to thank the Committee from the Board. That is quite a tome you guys created, and it's just a stunning amount of work by dozens and dozens of people. We would like to thank you for the effort.

I mean, you know with striped bass you're assessing the stock, actually two stocks. With this you're doing 23 separate stock assessments, an amazing amount of work. Thank you for everything you've put into it, and the whole crew on that.

PRESENTATION OF
PEER REVIEW PANEL REPORT

CHAIRMAN ARMSTRONG: Before questions, I would like to bring up Dr. Karin Limburg to prevent the Peer Review of this assessment. Dr. Limburg.

DR. KARIN LIMBURG: Hey, Dr. Armstrong, how are you?

CHAIRMAN ARMSTRONG: I'm good, how are you?

DR. LIMBURG: I'm okay, on the fringe of the hurricane. I was told I would be able to show my own screen, so I'm hoping that the magic is happening. Good morning everybody, and good morning, Commissioners and good morning to all the other folks here. I thought I would be on camera, so I actually put on my favorite fish shirt, which if you use a little imagination they look like shad.

Anyway, we'll just go with the PowerPoint here. This is actually my fourth peer review sharing, and I've done American shad before, actually. Let me just put this into show mode. I hope all of you can see this okay. If you do have questions, you guys can either ask afterwards, I think that is probably the most efficient way to do it.

I like this image from Denton, I think his name was Charles Denton, was a marvelous artist, and created many, many, very nice fish prints. I think the shad one is one of the finest, of course I'm biased. Just for background, I did my P.H.D. work at Cornell, in a period of pretty good shad abundance. I studied the young of year, actually, and they're moving out of the system. I know shad reasonably well.

This is what the team looks like, the faces here. We had a really interesting group of folks. Craig and I, I think you would say are more or less pure fish ecologists. Jamie, Mark and Quang are modelers. Jamie is kind of also gets out in the field quite a bit too. I think Mark may as well. That is a microphile. That is a real trophy morale that I'm holding in my hand, not to compete with Craig over there with his salmon.

But the three in the middle are from the west coast, Jamie and I are east coast. I'll also point out that Jamie and I, I think are the only two people around from any of the parties who were there before, including I think the Commissioners, who were involved with the stock assessment in 2007. Jamie and I are the institutional memory of that.

Because of that I've put in a little bit of comparisons with previous assessment. The process of assessment, we had this new one. This was the first assessment since 2007, so 13 years later. We had the first virtual peer review workshop, so we were on Go to Meeting for most of a week doing this, and I would say it went pretty well.

It's not quite the same as face to face in person, but next best, I guess. The review that we did looked at the data inputs, the model results, and all those kinds

of things, and the overall quality of the assessment. Mike rightly pointed out that this was a monster assessment. It is really a credit to the dedication and the hard work and qualities of the team of the stock assessment team that put this together.

I want to give you guys a little bit of context on this. I heard something that nowadays is sort of forgotten. I don't know what you Commissioners think about this, but the American shad was the number one fish, aside from cod, through much of American history. In fact, it was so important that in the 1800s it was one of the top if not the top, species of fish that was developed in aquaculture, because it was such a desirable fish. As it says here, it stands in very high, if not among the head of luxuries which our rivers afford. This is the first article in the transaction of the American Fish Cultural Association, which was renamed the American Fisheries Society, which is the world's largest professional association of fisheries biologists and managers, and everybody else.

It was really a tremendously important fish, and it's kind of been forgotten now, because of the phenomenon that you may have heard of called the shifting baseline. Whereas, as populations decline over time for one reason or another, we humans are very adaptable, and start moving on to other things, and so it sort of gets forgotten.

The question is, you know, so these are data which Mike Bailey also showed from just fisheries catches, so of course the catch statistics may be driven not just by the abundance of fish, but by people's preferences and other factors; weather and so on. But there is a remarkable trend in here, I think, and this, five-year trend line sort of smooths it out and you can sort of see.

Can you guys see my arrow on the screen? It shows, what we're seeing here are almost like stanzas, where this is sort of leveling down. Although I can't definitively say it's because there are fewer fish. We are very likely at historic lows of American shad, or they are moving north is a possibility too.

But the thing that really gives me pause is, and I was tipped off really by Jim Cummins who I saw is attending here today too. He is a tremendous historian of the Potomac, and he had pulled together some data for the 2007 assessment, which showed that the Potomac was actually very full of shad in the early 1800s.

If we plot those data, what I'm showing is something that is normalized from, or sort of standardized to landings per river kilometer. What we can see is that the baseline of 1950, or the '60s and '50s, is so much less than just one river in the early 1800s. We have a rough idea that we are in a very different regime now.

Where our changes are today are almost unnoticeable when you scale it up to what was here historically. I also want to point out that shad back in the 1940s, when this National Geographic article came out, were reasonably larger than they are today too. I mean we can show some nice pictures of big shad, but they're really not like they used to be.

That is also something that comes out in the assessment report. Overall, the Peer Review accepted and passed the assessment. I wanted to just get that up front, as we did in 2007. These are the terms of reference that we have, what I call the marching orders. We were asked to evaluate the choice of the stock structure.

I assume that these are fairly standard, or more or less standard terms of reference. Looking at the thoroughness of the data collection, how all the various data were used and treated and presented. The methods and biological reference points, the models of which there was an abundance of models. Then for each document we were asked to look at the best, and make recommendations on best estimates of biomass, abundance exploitations. For management, although we sort of said that a lot of this was probably, we would be hesitant to use all of it for that. But if possible, just by alternative estimation methods. Then also, examine the choice of reference points and the methods that we used to determine them, and then look at the stock status determination.

Then also, finally, review the whole set of recommendations that were provided by the Technical Committee. Then make any additional recommendations as well. I'm not going to be able to get through all of them in this talk, in this presentation. The TC and the Review Panel both made a number of recommendations.

The Technical Committee had a whole slew of them, it's a great list, and then we added to that as well, which all of these are in the report. I wanted to show you, this is something I showed in 2007. This was to show what kinds of data were being used at that time. I think they actually assessed, broke the system up into something like 30 stocks instead of 23 that time.

What you should see here is that there is a lot of blanks. There is a lot of exes, which are unreliable data or deemed unreliable, and there were many fewer black dots of things that were used, which were mainly from commercial fishery data or adult data. There was some juvenile abundance information too, but really it was sort of sparse.

There was some information on dams, but that was sort of more or less a footnote. The kind of information that was available then was not, you know one of the things that the Technical Committee and Stock Assessment Committee knew at the time was that this was not a stellar dataset. I think that perhaps the shad and river herring folks since then have been laboring under a feeling of not having enough. Now, I think they have actually got quite a lot.

Then to compare that to today. Yes, there are some blanks in here, but some of them are because there just aren't fish passage facilities on a lot of these systems, so there is no way to count things on a facility that doesn't exist. But there is a little more data. Datasets are much improved from before.

I want to make that point, because I think the states have really been putting in effort on this, and that's very commendable. No system has everything. I guess that is something we want to strive for. I can also point out that age determination, which is kind of a fundamental thing we need for understanding a lot of processes in the biology and natural history of shad, as was basically most other fish species.

We see that mostly there are a lot of esses in this column, S stands for scale, and scales are just not generally as easy to use to determine age of fish as their otoliths. As Mike Bailey pointed out, otoliths, you have to kill the fish to use them, but they are definitely better. It happens to be one of my very arcane skills to do a lot of work with otoliths. If you look me up, you'll see a lot of my recent work is on a lot of otolith work.

These are just some pictures so that you get a feel for what we're talking about here. Here are some scales, these are some scales of American shad on the left. What you can see here, as I pointed out with the arrows, are spawning sets, and those are actually made because the scales actually have some calcium in them, and as the fish are running up the rivers they are probably mining the calcium out, and the scales actually erode. There may be other reasons why they erode too, but that is certainly one of them.

Now they'll erode and then get kind of raggedy, and then as they go back out to sea and they feed and grow some more. The scales start putting on new growth, and they lose that check, which is actually very nice, and it reads out like logbooks right, so we've got sort of an idea. Each fish is sort of telling the story of its life.

Then otoliths as I said are a lot easier to use to age shad, although they are not completely easy. I would say that the clarity of the rings, which you can sort of see here in this image, do get clearer as you head northward. It probably has some kind of a temperature thing. As you look at them further south, they are kind of muddier to look at, trust me I've looked at them.

But you can get age information and my own specialty is to examine chemical composition of otoliths too, and we can get a huge amount of very interesting

information from the chemistry as well, although still a research brunt in many cases. But we can use them for example, we can look at in many, many systems we can look at the strontium that is imbedded in the calcium carbonate of the otoliths, and get a very clear idea of their movement in and out of salt water.

You can look at migration histories that way. I wanted to talk a little bit about what I call the modeling and statistical universe here, because there were really almost a dizzying number of models that were used in this analysis. If we're looking at abundance and size at age, those kinds of thing.

There was a suite of things that they run through. Power analysis is a statistical technique to ask, is the size of the change in the data big enough to see it over just background statistical noise. If that was the case, they could look at the auto aggressive integrated moving average type model, the ARIMA model, which is a time series technique to see if there are trends.

As Mike said, they were specifically using those to assess the changes since 2005, which was the last real ASMFC action mandate to stop the offshore directed fisheries, so they're asking that. Then also, they used what is called a nonparametric technique, the Mann-Kendall to ask more or less palliatively, have the trends been up or down.

Those datasets that were used, some of those extended back quite some time, so that they were of variable length. For biomass, the amount of tissue that is produced out there. They were looking at different ways of doing it. If there was no age structure data, or if it wasn't so good, they employed these Delay-Difference models, which Mike discussed.

Otherwise they used models that could take advantage of age structure, and they fall in a class called the Thompson-Bell Spawner/Recruit. How many spawners are produced per recruit. For total mortality, they employed a technique called catch curves. Some people don't like them, or some experts don't like them, but they are very, very often used, and I will say that the Stock Assessment Committee used them very carefully, and assessed them very carefully. I think they went the extra mile to assess them by looking at different ways of calculating them, for example. If you have really data rich information for river stocks, including fishing data, then they could go forward with these so-called age structured assessment models as well, and Mike also talked about those.

That's what I called kind of the universe. As we were reading through the entire report, you know you have to sort of bear in mind that there are these many moving parts of it. Then on top of that, there were two new modeling approaches, which haven't been even considered, I think, in the previous assessment at all.

These, I think, are probably the result of the thinking and the mood from the 2007 assessment. One was that inland habitat modeling, which Mike eluded to, looking at the impact of dams on the systems, and the other was to try to address the ocean-mix stock. The fisheries in particular, although I threw in this shark to remind us that shad are, of course, subject to natural phenomena like predation as well.

We're not the only mouths out there going for fish. I also wanted to summarize the findings, and I wanted to compare nowadays findings for the status of your stocks again. The 1998 benchmark, which was reported on in the 2007 assessment and also just for comparison, and then also the 2007 itself.

What we have are hopefully the symbols that make it somewhat clear. Things that are sort of yellow are kind of stable, things that are green smiley faces are sustainable and increasing, and then the sad faces are declining, or unsustainable. Question marks mean not determined. What we see is that for the 2007, things were looking kind of mmm, not necessarily so great. I think this certainly puts some caution into people, as they went forward.

Then in '20, now 13 years later, the status was broken up into two items, the total mortality and the abundance. What we can see is that total mortality, I

made some of these smiley faces a little smaller, and shaded them a little bit less red, because these indicate that the assessment showed that the total mortality was unsustainable in only the most recent years, which was one of the things that the Committee looked at, versus longer term.

We have many systems where we just don't still know what that is like. The Hudson I want to point out is listed as having sustainable mortality, but I've put it sort of a little smaller with a slightly paler shade of green, because honestly, the population levels are very, very low right now. I think that it's indicating I think that it's stable.

But as has been said, the Hudson's abundance is depleted, so I've put a crying face on here instead being the system I know the best. Really the only other assessment that we have, as was mentioned before was for abundances is that the Albemarle Sound from the modelers was not overfished.

The other systems, again a tremendous amount of unknown, and it does make me kind of just as stepping back and asking. Well, here we know more about these dots than ever, and yet we still can't make these determinations. I'm not really sure why that really is, but it is something again to think about. Just the findings that we had. We accepted the choice of stock structure. It seems pragmatic. Now we know that the shad spawn in many systems. They mostly have a lot of fidelity to a natal river, like the salmon do. They do some straying, but not as much as they do homing. We think that the choice was good, and for some of those complex systems particularly in the south, where there are many rivers that come out in embayment's and things like that.

The choices of how to group them was good. Evaluating the thoroughness of the data collections, this is a quote from our report. "Our Review Panel was very impressed (and a little overwhelmed) by the amount of data available for assessing American shad stocks." The datasets were comprehensive and thorough.

There was an acknowledged weakness on the part of the Stock Assessment Subcommittee, as you saw before, that many states used scales to age their samples, and we recommend as they did the use of otoliths. I think all states are now collecting otoliths. You know I don't want to beat on this too much, but it's knowing how fish age, what that composition is, is quite important, for at least the current way that the assessments are carried out.

The models really do depend on knowing age. I can just say that I work also in the Baltic Sea on cod over there. They are in such bad shape from really low oxygen problems in the Baltic Sea, and other problems too, that they don't even lay down good rings on their otoliths anymore. We're using other methods to tease out the age from the otoliths, instead of looking at rings.

Evaluating the models and so on, we were impressed by the number of analytical methods. As I said, there was sort of a dizzying number of methods that were used. We did find that the analyses were complementary too. For the trends, the trends will be followed up, of course, as we go into the future.

It was recommended that from the more advanced time series analyses could be used. Instead of just looking at ARIMA models, you could use other types that would remove sort of any kind of temporal trends, like an uptick from, you can separate out those to see the ups or downs from the other wiggles in the data, and look at the other wiggles, just putting it simply.

Their techniques go, such as Dynamic Factor Analysis that look for underlying factors, so for instance there may be some climate driven factors, or something else within a large region, like one of the metapopulation regions. Those could be employed too. The Committee found that the Thompson-Bell biomass per recruit model wasn't a good model for semelparous stock, it was designed for these recruit spawner stocks.

The other models were deemed to be appropriate, but as Mike mentioned, the Delay-Difference model

was modified by one of the experts on the Panel. Kerne actually developed some of these models, and so he helped them, helped the Committee to explore alternate assumptions, and add more diagnostics. That was quite useful.

The Catch Curve, we agreed with the Subcommittee that it is very impractical to split fishing from total mortality. I guess you've heard now from both Mike and myself about the other mortality that happens because, fishing is one factor in the suite of factors that lead to shad dying. It's difficult not to keep them together, I guess to split that out. We discussed the biases in the current method. Jamie Gibson in particular proposed an alternative that appropriates information from spawning history. He was very keen on that. That is also in our report, but I don't have time to go into it in detail.

Then for the age structured model, these are definitely the most advanced models that were used. The only systems that really had enough data to conduct these models was the Potomac and the Albemarle Sound, and they were fully explored with various types of analyses and diagnostics. The Review Panel had three recommendations.

One was that one of these models, the simpler versions of these so-called statistical catch at age models broke down, because they didn't account for the availability of shad to actually be caught. Basically, what they were doing was catching fish that shouldn't have been caught, because they didn't separate out mature fish from immature fish.

This does actually get into something else, which is that immature fish are assumed to remain in the ocean, and not run with the mature fish into the rivers, where they can be caught. I know from my own work that that is not always the case, at least I've studied one-year old fish, and I know that they go back a lot of times with the spawners.

We don't know how many, what fraction of the population it is, but we do know that we can find them coming up in the ocean. I think it's a nuanced issue that probably bears more research, and also to run simulations under different assumptions of fishing and biomass. Again, getting at this question of where are the immature fish?

If they use one of these more advanced models, the stock synthesis model, they could model the immature fish separately from the mature fish, or even better would be to have a shad-specific model, assessment model. This would of course take more time, because it would require more data. It would require better estimates of spawning marks.

Getting the idea of like how many times do these fish actually go up into the rivers. That again, it's a long-term goal. It's a very good goal, and I think it would be something that would be wonderful to have some P.H.D. students work on. The habitat modeling, we were impressed with this analysis.

We thought that this perked the whole assessment up to a different level, and we think it's necessary for diadromous fishes. We've seen, having often shared the reviews of American eel and river herring in 2012, the fishery came up then too. But we were told, well you can't really do much about it, because the only thing that fisheries managers can manage is the fishing level.

But we actually think that this is something that can be used, that we now have this information, and we can say, we or the ASMFC Commissioners can make strong recommendations to other stakeholders to remove dams when it's possible. I think there is just a growing body of evidence that dam removal is probably the best thing for improving the sustainability of diadromous fishes, or not to build them in the first place, which is going on in other parts of the world. I think that is a very important finding that comes out of this, and I do encourage you to consider that. The ocean mix stock modeling, the report noted that the results were extremely variable, the datasets are very variable. But the Review Panel thought that the approach that was used was the most appropriate. It was an expert from NOAA Fisheries who conducted that analysis, and the Panel

felt that the estimates would improve with better monitoring of ocean fisheries.

One point I want to make is that shad really connect the dots. All these diadromous fishes connect the dots between the watersheds and the open ocean. From the headwaters, which influence a lot of the water's dynamics and the land use, and the damming, and so on, the pollutants that go in all the way out to the sea.

These fish are real connectors, and you know if you can manage them sustainably and well, it means I think that we're dealing with some of our problems in a more appropriate way. For the estimates of biomass, abundance and exploitation, we felt that this was by and large done well. We did make the point that the Delay-Difference model is not designed to be used on semelparous stocks.

We also agreed that the total mortality being highly variable, or the estimates of certainty are not very certain. Wide confidence intervals means that that is the case, and have to be a somewhat a little bit "grain of salt" on this. For reference points, we appreciated the many ways that were done for assessing so many populations and locations.

Where status was undetermined, there was still an awful lot of information that was really informative. I would be reading along in these various river chapters, and think wow, this is really an amazing amount of data, and then at the end they would say, status is unknown. I think that they are probably close to being able to say something in many of the systems.

But I think the Subcommittee was hesitant to make a concrete determination often. For their recommendations, there were just many, many. One I'll just point out myself, because I think about this in the context of the Hudson, although not all these predators are in the Hudson. But young of year, Mike Bailey said that very little is known about young of year.

I kind of question that, because there are so many Masters and P.H.D. studies that are focused on shad and river herring, I think. It's really getting some of that information really incorporated into stock assessments may be where the gap is. But one of the things that I'm increasingly aware of in the Hudson is that we have a suite of really novel introduced predators.

They have been introduced either by moving in through connected waterways, like the Eerie Canal connecting from the Great Lakes over into the Mohawk River, which is a tributary to the Hudson, or through introductions, which are the case with things like the channel cat and the blue catfish on top, which were introduced as sportfish in the south, and are moving their way up. The channel cat actually prefers to eat select from alosine herring as prey.

Up north we have more pike, we see more pike, and then of course the nasty looking face there is the snakehead, which is making its way through parts of the range as well. Just one of the threats. But there are other things, there are many, many, other things that we have recommendations for. All of them are to get an idea of what these fish are doing in their ecosystems. But from sort of the small scale, fine scale genetics on up to their role in these systems. The other thing to mention is just that we also can't forget that climate change is moving right along. Although this panel comes from the Stock Assessment Report, and I would have really like to have seen us go back to the earlier decades, because then you'd really, really see the changes.

These are catches as seen from the NOAA Fisheries. When you see the changes in the dynamics of where the shad are being caught has really moved northward. I think John Hare, who is on this call I think, and Janet Nye and their colleagues have studied this quite a bit, looking at how many stocks of fishes are moving northward, and shad is certainly one of them.

The Committee used climate projections, the BAU stands for business as usual projection, and then with some mitigation, some climate mitigation, looking at the impacts of rising temperatures on the parameters of shad growth. Even with mitigation we're going to

see declines, and as I mentioned we're already seeing some declines.

Whether those are directly from you know the sort of metabolic task of rising temperatures making fish respire more and grow less, or if it's a change in the food web or some combination. It's likely to be there. It really means that we have to be more precautionary. It doesn't mean we should shut down fisheries, where they can be prosecuted.

But we just have to think about it more. It's more like, I work on ocean deoxygenation it's one of my research topics. There our recommendations are that for coastal systems that are subject to dead zones that management really has to take care, really take care of nutrient management, so as not to exacerbate that problem.

It's the same thing here. We just really have to think about it more holistically. For shad and shad fisheries to be sustainable going forward, we do need to think in that broader context. The watersheds to the sea I'm very glad to see in this report, and climate change, which I'm glad to see in this report, and continued improvements to monitoring and data.

Don't wait, please don't wait another 13 years for the next benchmark assessment. We've discussed how that could be, the timeframe could be shortened up and maybe split apart to ease the burden on the Committee. Thanks for listening to this part of the presentation. I just wanted to end with saying that shad is an important, important fish.

We forget so often about it, but it's one of my rites of spring. That's John Waldman in the picture, we were fishing in the Delaware this spring, where it's legal to take home fish. I cooked up some shad roe, which is absolutely awesome, and smoked some shad as well, which is totally awesome too. If you have questions, I'll do my best to answer. Thanks for listening.

CHAIRMAN ARMSTRONG: Karin, thank you so much. That was a great review. But the best part is, I just heard you volunteer for a Review Panel shorter than 13 years from now. That's awesome, we'll just pencil it in. If the assessment is daunting, the review is just as daunting. It appears you had a great panel to work with. The advice coming out of there is fabulous, and particularly your historic and high-level overview of shad, very, very helpful. You know the perspective, we're at very low levels, even though we look at some runs and say, hey we're doing good. We're really not doing good across the board. We have a lot to think about coming out of this. Our first task will be to consider accepting the assessment and the review for management and use. In preparation for that I would like to open up the floor for questions for Mike and Karin, and Board comments on the assessment from the Board. The floor is open.

MS. KERNS: You have questions from Marty Gary, Justin Davis, and then Loren Lustig. Mike, I think you should also know we have questions from members of the public, just as an FYI for later.

CHAIRMAN ARMSTRONG: Okay, and we'll cover that when the Board members are done. Marty Gary.

MR. MARTIN GARY: Thank you, Dr. Bailey and Dr. Limburg for both all of your hard work, and also two really spectacular presentations. I understood I think most of it, so that was a good highlight for me. I appreciate everything you put into bring this forward to us today. I have two questions. If either of you want to try to respond to them it would be appreciated.

Just a little bit of context. Dr. Limburg, you applied a green smiley face to the Potomac back in 2007. For folks listening and members of the Board, a lot of that I assume is attributable to our fishery dependent bycatch CPUEs, which showed a trend of ever-increasing abundance of American shad in the Potomac.

Every year I look forward to getting the new index values updated, and media calls coming in. Amongst all the other challenges we have that was one of the bright spots. Now we have this assessment to shed some new light. I heard Dr. Bailey say that the

Potomac had unsustainable adult mortality, but it may not be attributed strictly to fishing mortality, which could either be as I understand it, from the bycatch fishery we have, our gillnets and pound nets, or the brood stock collection.

For folks on the Board, PRFC typically issues somewhere between six and eight scientific collecting permits to collect broodfish, which are strip spawned and then taken to hatcheries for restoration efforts in other rivers. This typically happens just down from Mt. Vernon and Monticello, hence the "founding fish" and the importance too of shad in the Potomac, but certainly the eastern seaboard.

But my questions are, and just one other item. We also, Dr. Limburg, you mentioned in one of your last slides predators. I think a lot of folks know we have a huge biomass of invasive blue catfish in the Potomac. It just so happens the epicenter of their distribution overlaps with where shad spawn, and presumably where the juveniles are using habitat in their early life stages.

I guess the first question I have, and maybe it will be speculative in your answer is, what do you think is contributing to this unsustainable adult mortality in the Potomac, specifically? I know some of the research that's been done in the Potomac and in the Chesapeake show that predation on the alosine by blue catfish has not been that significant. But I can't help but believe, given the biomass we have, it's having a significant impact on them. I guess the second question, and it may spill over into our management response dialogue, is the efficacy of the continuity of that bycatch in our fishery dependent collection of data. Where is the value of that going forward, if there is any? Again, sorry for that long series of dialogue leading up to those questions, but again, thank you so much for your presentation, and I'll listen.

DR. LIMBURG: Mike, do you want to start off?

DR. BAILEY: I think to start off, I would introduce Jeff Kipp, who worked on some of the Potomac specific models. We may tag-team that question. There were a bunch of different parts to it. I'll start off by talking about the catfish, and there was a recent paper that came out looking at the two different, I think blue and the flathead, and showing that while the abundance was higher for the blue, the flatheads seemed to really focus in on alosine as a preferred.

They may have had less numbers, but they were looking for alosines more, which may be more problematic than just large numbers. It's probably a big mix there. But certainly, we did include that, because it is an important component. I think with that I'll just kind of hand it off to Jeff, to talk a bit more about the Potomac model.

MR. JEFF J. KIPP: Just to touch on that research Mike cited on the catfish, the invasive catfish species. It did find that blue catfish are more opportunistic, and so their diet tends to be more proportional to the abundance of prey species in the river. You know take that into mind, as shad abundance would increase it would become a bigger component of the blue catfish diet.

If you look at the trends in abundance that we have, so we have some young of year indices, and some adult indices in addition to what Marty mentioned in the CPUE index. You can see a very clear increase in shad abundance in the early 2000s. Then those increases tend to level off. If you look at the trend analysis on the indices of abundance in the assessment, there were no trends detected since 2005.

But if you look over the full time series of those indices, which go back into like the '80s or early '90s, they did find increases in abundance. That is mostly attributable to those ramp ups that occurred in the late '90s and early 2000s, but have since leveled off. You know it could be potentially blue catfish are taking advantage of that increase in abundance that occurred in the early 2000s.

But in addition to that, the only other sources of mortality that we know of there going into the adult mortality estimates out of the age composition data, are bycatch mortality, and then the brood stock

mortality. You know we recognize that those brood stock fish are taken for the purpose of improving recruitment and raising those fry. But they don't get the chance to repeat spawn, as Marty mentioned they're sacrificed.

They don't have the opportunity to come back, so they contribute to some of that adult mortality. But in addition to that there is the nebulous additional sources; habitat, what's going on in the ocean, the ocean bycatch, which we still just don't have a grasp on with the available data, and how much it contributes to each of the individual stock that are overall mortality. Hopefully that was some good context, but let me know if that didn't fully answer your question.

MR. GARY: No, thank you, Jeff. I appreciate that. Then I don't know if we want to defer this to management responses, but I don't know if any of you can get your thoughts on the value of the fishery dependent collection of data that we have a pretty long series on now, and where you see that standing going forward.

DR. LIMBURG: If I can just jump in, I think any long-term data are important to have. We're facing the issue in the Hudson River system now that some long-term monitoring has ceased, and we are trying to reimagine ways of making it happen again and how that should be. I think you obviously can't see many phenomena if you don't have some kind of long-term data.

You know understanding some of the drivers on the data are very important, fisheries changes can be from behavior, for example changes in what people like to do, the gear that they use and so on. But I still think it's invaluable to have the data, just personally speaking.

MR. GARY: Thank you, Dr. Limburg, and thank you Mr. Chairman for that generous apportionment of time. Thank you.

CHAIRMAN ARMSTRONG: Toni, I have Loren third, I missed the second hand up.

MS. KERNS: It's Justin Davis, and then after Loren will be Cheri Patterson.

CHAIRMAN ARMSTRONG: Okay, Justin go ahead, Justin Davis.

DR. JUSTIN DAVIS: I'll just start by thanking Mike and Karin for a few excellent presentations this morning, and thanking the Stock Assessment Subcommittee for all the work that went into this document. I've got a two-part question that has to do with these terms sustainable versus unsustainable mortality, reference to the total mortality reference points.

I think those terms, sustainable or unsustainable. If you ask ten people, what does that mean? They would say sure, I know what that means, but then if you ask them to expound upon that you might get ten different answers. I wanted to provide how I'm interpreting those terms, and see if that matches with what the technical folks interpret it as.

I view the idea of unsustainable mortality here as meaning that the stock is experiencing a level of mortality that is preventing it from recovering to a level of abundance that would be typical of that stock, under sort of a baseline natural mortality level that is typical of, you know of fish of this life history and maximum age.

But I don't interpret it to mean unsustainable in the sense that we would expect sort of extirpation of local extinction of the stock, in some reasonable timeframe, 20 years, 50 years, and then also that level of mortality may not even lead to declines from where the stock is now. That the stock may be able to persist at this level of abundance, with maybe a truncated age structure at that level of mortality. I'm just looking for maybe a little clarification on the interpretation of those terms, sustainable versus unsustainable mortality. Then related to that, what was the rationale for changing the level of what was defined as unsustainable mortality in this assessment, making it more conservative relative to the past assessment?

CHAIRMAN ARMSTRONG: Mike, could you answer that?

DR. BAILEY: Yes, I think for this one I'm going to pass it off to Jeff as well.

MR. KIPP: Thanks, Mike. Justin, I would say that your interpretation is correct. We chose a reference point based on the per-recruit analysis, so we're shooting for the D40 percent, or a mortality that gives us 40 percent of the spawners per recruit under that baseline sort of natural mortality you mentioned, based on the longevity of the species.

In theory, this species could stabilize at a lower abundance under higher mortality rates, so it doesn't necessarily mean the unsustainable doesn't necessarily mean that the stock is trending towards extirpation. I think the other question was, why we chose the Z40 percent changed relative to the last assessment of the Z30 percent.

The Stock Assessment Subcommittee did a review of the literature that are available on these per-recruit analyses, which are typically meta analyses on various stocks, and looking at sort of what that sweet spot in mortality is that you would want to shoot for. After that review, we felt that D40 was a more appropriate level.

It's a bit more conservative, and that is to note sort of the data uncertainties we're dealing with here, and just the uncertainty in this species being at such a low level, what the uncertainty is in those appropriate mortality levels. I think it is sort of nodding to the uncertainty here, and the precarious state we think a lot of these stocks are currently in, and that we think we should be shooting for something a bit more conservative than was being targeted in the last assessment.

DR. BAILEY: To add to that, I think some of that increased uncertainty comes from a better understanding of aging of the fish, and certainly we have a lot more quantitative data now that we can say, scale aging that was used in previous stock assessments probably was not nearly as accurate or precise as we thought it was.

DR. LIMBURG: That's kind of a little bit of a black art to age from scales, I think. I will say that some people are very good at aging with scales.

CHAIRMAN ARMSTRONG: All right. Loren Lustig.

MR. LOREN W. LUSTIG: Thanks to Dr. Limburg for a very fascinating report. I really have two questions, and they relate to historic abundance. Predominantly I'm interested in the Susquehanna River. I was interested in the photograph that was shown of a commercial angler there with a small skiff, and these really large American shad.

My first question is, based upon my own recreational fishing in the lower Susquehanna, is the hickory shad that comes up just up the river, just before the American shad. Is the hickory shad a species that would have ever been commercially harvested? I'm interested in knowing if the population of hickory shad shows the same sorts of fluctuations, perhaps based upon riverine habitat quality as the American shad. If it does, then it would be perhaps data that we should consider as we move forward with our American shad assessment. Thank you.

DR. LIMBURG: I'm not sure who wants to take that.

CHAIRMAN ARMSTRONG: Loren, who do you think should answer that?

MR. LUSTIG: Well, the person with the most knowledge. I would wonder if Dr. Limburg could comment about that.

DR. LIMBURG: Okay, I can say that I don't think there is a lot of fishing on hickory shad. I remember there was a guy, I think he was at Virginia Commonwealth University, who used to study them. He commented that they weren't very good eating, which surprised me. I've never tried them myself. I've only seen one hickory shad myself.

They are not as abundant up north as they are in kind of the Mid-Atlantic states, but they may come up of course with climate. I think what I know is that they are kind of recreationally angled. But I don't know how much they compete, for example, for habitat with American shad. I think again, I think there are a

lot of questions, a lot of just open unknowns about them. It's the fate, unfortunately of fish that don't produce as much income to be less studied, unfortunately.

CHAIRMAN ARMSTRONG: Okay. Cheri Patterson, next question.

MS. PATTERSON: This was very informative. I really see a lot of work involvement here, and I am in awe of the work. Is it possible to go back to Dr. Limburg's presentation, where it shows the northward movement of shad stocks?

DR. LIMBURG: Yes. This is, if you can make my screen visible. I don't know if it is or not.

CHAIRMAN ARMSTRONG: It's not yet.

MS. KERNS: Cheri, if you could ask your question and we'll get you there. It's just going to take us a couple of minutes, so if you could keep asking questions, just to keep us moving along.

MS. PATTERSON: Okay great, thanks.

CHAIRMAN ARMSTONG: Do you really need that, Cheri? Could you work around it?

MS. PATTERSON: Well, I could try to work around it. My question has to do with, with this stock assessment was there any sort of analyses, and I'm sorry if I missed it, to move some of these datasets, or to think about moving some of these datasets northward? I believe in long term datasets; I think they are very important. But if they are showing some trends that are not easy to analyze, and it looks like there is a northward movement of this population. How is that going to be analyzed in the future, so that we're not necessarily looking at downward trends in all the wrong places that we might be literally following these species, as they are doing this northward movement? I'm just concerned about the habitat and life cycle stressors that might be affecting them in the Mid-Atlantic, further south and such, and we're not really capturing their northern movement into new habitats.

DR. LIMBURG: I can take a stab at that. Cheri, I think that was a great question. I think one of the big questions for me is, with regard to these alosine herrings that have very broad latitudinal ranges and site fidelity. We know that they establish these in genetically distinct spawning populations.

One of my questions is, are they, and you know we're only looking at a tiny, tiny moment in time over the course of their evolution, and they've been projected to massive glaciers, glaciation events, and probably warming events and hybridization, and very flexible fish evolutionarily. But the question I have in this particular moment is, are the populations just going to be winking out in the south, and enlarging, expanding to the north, or are we going to actually see hop scotch movement of populations from the south to the north?

That is the kind of question that can be addressed by genetic analysis, and I believe there is some of that work going to be started. I think it's one of the big questions for these fish. It matters, I think quite a lot. For example, if the hop scotch hypothesis is correct, then perhaps the reason why shad are just about gone in the Hudson might be because they moved north.

Maybe we have to wait until southern populations start to colonize. I have no idea, it's an open question. But I think we'll probably be approached to asking that, is to try to do the genetic work, is my guess. From otolith chemistry we can also identify populations. But I don't know that it would address exactly the questions that you're asking now.

CHAIRMAN ARMSTRONG: Thank you, Karin. Mike Bailey, would you want to add to that?

DR. BAILEY: It's a hard question, and part of it is the latitudinal gradient of some of the life histories, and also some of the habitat, which more southern rivers typically have a dam much further, marked out much further. I think it's a good question, it's one to think about. She gave a great answer. I don't think we can do anything but make up stories right now.

It's something to consider though, with climate change and shifts; not only the freshwater shifts, but also the marine shifts. Right now, we are still a lot of open question to where are all these fish moving at sea. That may be a bigger factor, if fish from Florida have to add an extra 500 miles north in their oceanic journeys. Well that may make a much bigger difference than fish off the Merrimack River have to go. It's really a confounding question. There is a lot of interesting things to think about, but I don't think we have any solid answers.

CHAIRMAN ARMSTRONG: Toni, more questions from the Board?

MS. KERNS: Yes, we have Bill Hyatt, Lynn Fegley, and Roy Miller, and Emerson Hasbrouck.

CHAIRMAN ARMSTRONG: Okay, let me write those. Bill Hyatt, please.

MR. WILLIAM HYATT: One of the things that surprised me from this assessment was the fact that current fish passage only for about a 4 percent or so increase in potential spawning. That surprised me, because it seems that fish passage work is being done all over the place. I would have expected a much higher number.

One of the things that I'm wondering is if there was any assessment done on how much of that may be lack of (broken up word) due to inefficiency of existing fish passage facilities. How much that 4 percent number might be improved from technological fixes of the existing facilities.

DR. BAILEY: Thank you, Bill for that question, this is Mike Bailey. In the analysis we did for the coastwide stock assessment, we kept those passageways static. Most of this work was done by Dan Fitch from University of New York State College of Oneonta, and Joe Zydlewski from USGS. For different rivers they have worked with very similar models to look at different passage rates, and they do make a difference, especially adult bounds remigration.

For this coastwide model we kept it a bit more simple, and I think if we did increase that number of passage rates, we would see a greater increase. But we didn't run a sensitivity on that, at least that I have at my fingertips, to see how much that 4 percent could increase. For individual river models they have it, for this coastwide one I don't have it at my fingertips.

MR. HYATT: There is a potential there on the spawner side?

DR. BAILEY: Yes.

CHAIRMAN ARMSTRONG: Lynn Fegley.

MS. LYNN FEGLEY: Thank you to the peer review, Dr. Limburg, and to the Stock Assessment Committee that is a phenomenal amount of work. My question is really basic. You know this species is so different than other species that we manage, where we have you know reference points, and we sort of understand what we need to do to manage fisheries relative to our reference points. Our action item today is to accept that assessment for management.

I'm trying to wrap my head around what that means. You know, so to Justin Davis' question about sustainability. It sounded like with the Z40 reference point it puts us in a place where we probably we wouldn't be rebuilding. Maybe we would be holding the population stable at this low level, but we would not be extirpating the population, although then we transition to climate change, and we talk about populations vanishing from areas to the south.

I guess my question is, basically what does it mean when we accept this for management, and what more could we possibly do? I love the habitat piece, because I think it gives us really a platform to work from with our partner agencies and other folks involved with habitat, as Dr. Limburg says. But I'm really trying to understand, if someone could help me. If we accept this for management, and we have a fishery that has unsustainable levels of mortality on adult fish. What does that mean?

CHAIRMAN ARMSTRONG: Thank you, Lynn. It's such a great question. It really crystalizes a lot of why we're sitting here. It comes to, do we just want to hold in place, or do we want to actually rebuild, which

might be much stricter than what we're thinking about. Why don't we start with Mike Bailey?

DR. BAILEY: That's a hard question, and frankly my work is more focused on restoration, so I look at this stock assessment from one aspect, in which there should be a lot more shad out there. I'm not sure that is what everyone else thinks. I'm almost going to skip that question, because I think, well I guess that is a question for the Board.

Are we looking to rebuild shad stocks everywhere, or are we looking to rebuild shad stocks in some rivers, or are we just looking to have better data on those shad stocks? I think that is more of a question for the Board than for me. For me it's restoration. We need a lot more fish than we have now. We're way below where we should be, and that starts with habitat, in addition to the more restrictive catch measures that has already been. I think the missing piece now is focusing on habitat work and continuing on with those limits to fisheries.

MS. FEGLEY: Can I follow up on that real quick?

CHAIRMAN ARMSTRONG: Sure.

MS. FEGLEY: To that point, does that imply that if you were to get that total mortality down below the 40 percent that you could begin rebuilding? I guess that is one of the things I'm trying to understand.

DR. BAILEY: Go ahead, Jeff Kipp. Maybe you can tackle that question better.

MR. KIPP: Yes, so the Z40 threshold is what we think is the appropriate level, and yet that should allow for rebuilding of these stocks, assuming that the juvenile mortality, so when these fish leave as young of year and then come back as spawners. Assuming that those mortality levels are sustainable as well, which right now we don't have the data to assess.

But in theory, that Z40 would allow for sufficient SSB per recruit to build these populations back to what we think are the optimal levels. I think we recognize the concern here about what do you do. It's a total mortality estimate, and again we don't partition these mortality estimates into their individual components, because we just don't have the data to do that.

One of the first things I think that came out of this assessment is again, to highlight that we need certain data components to be collected, most notably I think stock composition data from the ocean. There is bycatch going on, but we don't know how that bycatch is impacting these individual stocks.

It might be impacting some more than other, but we don't have the data to determine that now, because we don't know what the stock makeup is of that bycatch. I think data collection is one of the emphasis out of this, to get us to a place where we can better partition those mortality sources, and determine if fishing in a particular river is limiting the rebuilding of these stocks. I hope that helps address. But yes, it's a tough question when we don't know what the various factors are doing to these mortality rates.

DR. LIMBURG: If I may jump in also, just to say that yes, I think both Mike and Jeff are right. But remember that we're at such low levels of populations that a removal is proportionately more than it would be if the populations were really high. That is why we have to be cautious. Not saying to shut down fisheries, but I'm saying be cautious, and think about that.

I think it also gets at Mike's point of you know we need to tread on places that we normally haven't trampled, which is talking about opening up habitat. I've studied this myself in some of the rivers of the east coast. You know the biggest difference you could probably make is getting fish up the Susquehanna all the way.

You know taking down the Conowingo Dam. The passage doesn't work. I know Sheila Eyler is on this call, and we had discussions about this. They're doing truck and transfer now, but we know that the most effective way, if we really, really wanted to get fish up

and rebuild those populations there, it would be no dam.

That would be the way. The Susquehanna has other complications, it's got the Conowingo pool is full of sediments that the Chesapeake Bay Committee doesn't want to have rolling down into the Bay. It's got a lot of complicated things going on. But I think it could be managed, but it would take a lot of work and planning.

CHAIRMAN ARMSTRONG: In front of Roy, who is next, hang on a second, Roy. Mike, are there empty rivers that could help build up the population by restoring runs? On the east coast to restore runs that we haven't done anything about?

DR. BAILEY: I think there are. I think some of those rivers are, we could take for example the Penobscot River, which the first dam ahead of tide wasn't passing any fish, so we didn't know what was below that river. I think there is probably a lot of population below low on rivers that are populations that still exist that we don't know anything about, because they don't pass. There are a lot of opportunities in those smaller systems.

CHAIRMAN ARMSTRONG: Okay thank you. Roy Miller.

MR. ROY W. MILLER: Thank you also to Mike and Dr. Limburg, and to the stock assessment staff, and everyone who worked on this truly noteworthy assessment. My question, I'm going to apologize in advance, because I did loose Wi-Fi for about 30 minutes, and so if I repeat a question that has been asked and answered, I apologize. But I wanted to follow up on the question of Justin Davis, and also Lynn Fegley touched on the same thing, regarding these unsustainable populations.

I'm specifically referring to the Connecticut, the Delaware and the Potomac. Of those three obviously the Delaware is nearest and dearest to my heart, since I used to serve on the Delaware River Fishery Management Club for many, many years. But anyway, if the mortality is unsustainable, let's say in the Delaware, and the Delaware is essentially undammed, getting into the hundreds of miles upstream into the headwaters in New York state. We can ignore dams on the main stem, which is (broke up) compared to the Susquehanna. What can you do to turn that situation around regarding unsustainable mortality? In other words, would it be a waste of time to further restrict fishing mortality on the Delaware stock?

Would it be worthwhile to pursue that now greatly depressed fishing mortality over what it used to be many years ago, or at least at harvest, compared to what it was many years ago? Is it worth pursuing that last aspect of something we can control, namely fishing mortality versus other things as yet undefined? I'm curious what our two reviewers think about that particular question.

CHAIRMAN ARMSTRONG: Great question. Mike, why don't you take a crack at it, then we'll let Karin.

DR. BAILEY: I will apologize for a second. You broke up a little bit there, but I think I got the base of the question. While the Delaware does not have a dam, it does have some water quality issues in some years that are really left undefined. We don't know that component of the degradation affects some of our adults spawners, including those fish that may be spawning and then leaving later in the year, when water quality is detrimental to health.

We don't have that answer. I think that comes down to when we get to a lot of river specific questions. We lose a lot of the specifics of the river and what's actually causing some things. The Delaware certainly we see fish went way, way further than what other rivers. We have to understand, those fish that are making its way up in the headwaters. Are they able to turn around and make it out of the river with the water quality as is?

I think with that I'll bump it to Karin, but realizing that it depends on what our whammy bar is. If our one whammy bar is fishing, then that is what we have to adjust. We want to list in that framework of our fishing. But our real answer may be something that

we don't necessarily have our hand on, which is some of that other mortality that I think classically how models work may be tied into fishing, but it's not fishing at all, it's more of an environmental factor. With that I'll let Karin take the microphone.

DR. LIMBURG: Okay, if I were to put on my hat and play John Waldman, John would say that the commercial fishery in the Delaware Bay should be looked at. He speaks from having studied the stock composition in the Delaware Bay commercial fishery. When he studied it, I think it was around 2010, 2011, something like that.

I think 40 some odd percent of the genetic composition of that stock was Hudson River origin. This also reminds me that this is another thing that might be driving the decline in the Hudson too. I noted in the Stock Assessment Report that there has been a follow-on study of the genetic composition of that fishery.

The proportion of Hudson River fish now is half of what it was when John studied it, so over something like maybe an eight-year time difference, there was a halving of the proportions in the Delaware. That could mean that the Delaware population has grown more, or it could mean that the Hudson population has shrunk. I think that it points to something that has got to be looked at more, in the case of the Delaware. I can't really comment on, I would have to go back and look at the statistics on the impact of recreational fishing versus the commercial fishing in the Bay. The recreational, correct me if I'm wrong, but I think a lot of it happens above the Bay, and the commercial mostly happens in the Bay, in that particular case.

MR. MILLER: Follow up, Mike?

CHAIRMAN ARMSTRONG: Sure.

MR. MILLER: You are absolutely right, Dr. Limburg. That recreational fishery is primarily in the riverine portion, and much less so in the estuarine portion of the Delaware estuary. In fact, in the state of Delaware there is no main stem Delaware recreational fishery for American shad. That occurs quite a bit further upstream. In terms of the water quality. I would agree with Mike Bailey that that was a huge problem 30, 40 years ago. But I think we've come to grips with that problem over the years, and water quality is much less of an issue for the Delaware stock.

DR. LIMBURG: I agree.

MR. MILLER: In terms of Dr. Limburg's suggestion using John Waldman's data to look at commercial harvest in Delaware Bay. That is probably one of the few things that we could do, if we felt that that was potentially important. I'm not convinced that it is, but it's about all we can do to have any potential impact on that stock, but thank you for your thoughts on this.

DR. BAILEY: If I may add, I think there is some renewed focus on the Delaware. The questions maybe we're asking now or don't even need to ask now, by the time the next stock assessment comes up we may have a much better way to ask the right questions and get to the right answers.

CHAIRMAN ARMSTRONG: Emerson Hasbrouck.

MR. EMERSON C. HASBROUCK: Thank you Doctors Dailey and Limburg for your excellent presentations. My question is sort of relative to the issue that Lynn raised, in terms of what we can do here, how we can use this for management. In the review it was mentioned that there are five stocks where there is sustainable adult mortality, one of which was the Hudson River.

But then the Hudson River is also listed as depleted, and one of the comments was that it was depleted due to recruitment failure. Two-part question, I guess. One is, do we know what is driving that recruitment failure in the Hudson River? The second part is, is there really any stock recruitment relationship for shad in general, or in the Hudson River specifically?

CHAIRMAN ARMSTRONG: Mike, do you want to take a shot at that?

DR. BAILEY: I think it's that river is in Karin's backyard, and I'll bump it off to Karin or Jeff to answer those.

DR. LIMBURG: This is Fisheries Science 101, I guess. I'm in the spotlight or in the hot seat. I wish that Wes Eakin could chime in. I see it as a couple things, one is the possibility that the staff being so low as they are right now are being affected by that commercial fishery in the Delaware. That is one issue.

That is not really recruitment that is the adults, but they are not being caught in the Hudson because the fishery in the Hudson is closed. But fish don't respect our boundaries, of course. The other worry that I have is the juvenile mortality from predation, by and large. That's just not very well assessed, and I think the managers know it.

Again, it's just a question of how many hours in the day are there. This will be a great thing, again to sponsor some students to study, and get more of a handle on it. Students are relatively inexpensive, compared to staff. That is one issue. Then I think the third is the threat of climate change and increased storms.

That is maybe a little bit more long term, but I have a P.H.D. student now, Chris Knack, who suddenly realized that when he did his Masters, and then was going on for his P.H.D. he was collecting data for the P.H.D. during a double back-to-back hurricane, you know hurricane Irene on top of Tropical Storm Lee that were three weeks apart.

They basically, although they weren't expecting spawning shad, because it was in late fall. It ripped up the habitat so badly that there was essentially a recruitment failure of spawning year. As those phenomena happen, again it gets back to how do you make those, when we think about things like habitat restoration, how do you make habitat, not only great places for the young fish to grow, or fish to spawn, and then the nursery habitat.

But also, how do you make them resilient? It's not just shoreline resilience for people, it's also habitat resilience for the organisms that live in those ecosystems. Getting back to your question about sustainable mortality. My comment was, again I just think it's bumping along at very low levels right now.

MR. KIPP: This is Jeff. If I could just jump in and add a comment. I think that the Hudson is a prime example of the caveat we've included in this assessment, which is we don't know juvenile mortality levels. The mortality estimates that we've put forward in this assessment are solely from the adult fish that return as spawners, and the decline in that age structure when they return to their birth spawners.

There is this big gap between when these fish are young of year in the river, and we do have actually some young of year surveys. Then when they leave and go out to the ocean and stay in the ocean, aside from some that might return, as Dr. Limburg noted. We just don't know what the mortality levels are.

There could certainly still be factors that are leading to unsustainable juvenile mortality. Even when they do return as adults and experience sustainable mortality, they've already been impacted to a degree, to where they're not going to trend towards a rebuilding stock, because of that high juvenile mortality.

MR. HASBROUCK: Then relative to the Part B of my question then, Jeff, based on what you just said. Am I to assume then there really is no stock recruit relationship with shad?

MR. KIPP: It may just be that there is an additional factor that we don't know if it contributes to that stock recruit relationship. You know the young of year may actually be tied to the adults. Yes, I'm not sure if it's just something that impacts those young of year, and that it is suppressing them from increasing in their relative abundance. Yes, I'm not sure I have a better answer for you.

DR. LIMBURG: Emerson, I think that there is probably not enough contrast in the data now to see that, because the population is so depressed, I mean at least in the Hudson. If you wanted to establish a stock recruitment relationship you might be able to do it in the Columbia River, which has the world's largest

population of American shad, there are over 7 million there. It's a wonderful system, but it's not here, and they've got lots of shad out there.

CHAIRMAN ARMSTRONG: We're way behind now. If we can get questions more towards whether we accept this as a package or not, the review and the assessment. In the coming meetings when we're talking about actions, and should we do it. I think we can get into the meat of it more.

These questions are important, and they are really good questions. But we're going to have to cut off questions in a little bit, and there are a couple of public comments we want to do. But back to the Board. We're discussing whether we should accept this. Toni, do we have more comments?

MS. KERNS: We do not have any more questions from the Board. We have three questions from the public that I'm aware of.

CHAIRMAN ARMSTRONG: Okay, and we'll do that by hand raising.

MS. KERNS: The first one is George Jefferson.

CHAIRMAN ARMSTRONG: Go ahead, George.

MR. GEORGE JEFFERSON: Hello Dr. Limburg, great presentation. You had mentioned the shad line in Delaware Bay, and I wanted to cite the Waldman et al 2014 paper. We know a mixed stock fishery exists in Delaware Bay, and we know the Hudson River shad are depleted.

Why isn't the line moved north to protect those shad of a mixed stock origin, or those with the Hudson River provenance? Then one more question if I may ask. With regard to the habitat model, looking at dams. The Hudson River didn't show so much impact from dams, but there was a 60 percent loss of shad spawning habitat to accommodate navigation. How is that accounted for?

CHAIRMAN ARMSTRONG: Mike, do you want to try those? You know the first question was a management decision. Do you want to comment on that, Mike?

DR. BAILEY: The first one I will not comment on. I think there are other folks who could speak better to that. To the second question about the habitat model. The habitat model was based very much on dams and accessibility. In the write up, we did include some discussion about we're not talking about water quality. We know there have been a lot of changes to habitat, there has been a lot of changes to submerged aquatic vegetation.

Those weren't covered in this kind of big 40,000-foot new model. We do realize some river systems have habitat degradation that is not dam related, and we weren't able to get at that at a coastwide level, so we didn't get to it, then the write up should reflect that. For the first question I am not familiar enough with it, and I know there were decisions made that I had no part of. Maybe someone else could answer that better.

CHAIRMAN ARMSTRONG: Well I think, George I don't think the person is sitting on a microphone right now who can answer that. But clearly there has been a lot of work since that line has been set in Delaware Bay. This may very well be part of an action that we can move forward over the next Board meeting or two, under the recommendation of the Technical Committee, which we will be discussing in a few minutes. I'll leave it at that. Next public, Toni.

MS. KERNS: We have Jim Cummins.

CHAIRMAN ARMSTRONG: Go ahead, Jim.

MR. JIM CUMMINS: Thank you, Chairman, for letting me speak, and I want to also extend my thanks to the Committee and the Peer Review Team for an excellent job. I was involved in the 2000 assessment, I know it is a lot of work, and I really appreciate what they've done. A little background for the Board members. I'm a retired biologist, since 2016, but I have a 31-year career focused on fisheries management.

I started a DC Fisheries Program in 1985, which I luckily am probably the only living person that started

such a jurisdictional program. Then from 1988 to 2016 I worked for the Interstate Commission on the Potomac, including working on shad restoration in the Potomac. I've done that since '95 onward.

I remember when the Potomac was really in bad shape. We were told we weren't even going to find enough shad to start Potomac origin fry upstream of a modified dam. We couldn't beg, borrow or steal any eggs from anybody else, until we went out in the river, I got a Virginia waterman to help me out, and we successfully had a restoration from 1995 to 2002.

Then the Potomac became the river of brood stock for the Susquehanna, for Maryland Rivers, and for the Rappahannock River. I've seen a river change from nothing to really good, and I have to disagree a little bit with the conclusions on Page 227 that the Potomac stock is currently experiencing unsustainable mortality.

I will agree there has been somewhat of an abundance plateau in the population over the last four or five years, but the longer-term trend over the last 25 years has been strongly upwards. I support the Peer Review Panel's recommendation that the data quality issues are such a concern that the output for the current model should not be used to provide estimates for management purposes. One other factor to consider is the ocean predation and bycatch mortality. Again, with the Potomac as a good example, it's pretty much it's an undammed river now. It's got good habitat. It should be really increasing a lot, but we've reached a plateau.

I think a lot of that is due more to what's going on in the ocean with predation. There are few rivers coastwide, sadly that are doing as well as the Potomac. When the Potomac population is out in the ocean they are being heavily preyed upon, and probably in the bycatch there is a disproportionate number of Potomac shad that are taken in the bycatch fisheries too.

Still for over 15 years in my annual reports on the shad project I noted that. You know in order for the Potomac or any shad population to do well, it's really reliant on the whole population of shad up and down the coast doing well, because we have such low numbers. They are being heavily preyed upon.

The importance of shad in restoring other fish could also be mentioned. I mean at one time when the shad were really abundant, and other fisheries were doing well. You know we don't have that any more, it's really impacting other fisheries. Spencer Baird mentioned in 1877 report that the demise they were seeing of the cod was linked to the lower numbers of shad and herring that were, because of the damming of the rivers at that time.

It's important to keep that in mind too. But I do think the Potomac model and these advancements are really great. I liked the report in general. I would mention that I think it is actually time to open up the recreational fishery in the Potomac, which has been closed since 1983. With the recreational fisheries closure, the attention and care for the fishery really went south.

Not only did the shad become very rare, it became the forgotten fish. I am an advocate for a very light reopening of the recreational fishing, which is primarily in the District of Colombia, and letting a few fish be taken by those anglers, to keep up the concern for the fish. That is about what I have to say.

The blue catfish, I have long worried about that, because I was witnessing the Maryland and Virginia folk coming out and collecting the blue catfish in the spring for their stomach content analysis, while we had four different agencies out collecting shad for brood stock. At the end of the evening, since there wasn't anything we could do with those squished up fish, we cut them up and threw them overboard.

Some of the data on the blue catfish consumption of shad, even though it's light, it might have been part of it could have been due to the availability of freshly killed shad. I mentioned to Marty that one of the potential management measures we could take is we currently have a 10 percent replacement stocking on all these programs that are taking fish out of the

Potomac for stocking in other rivers. We could increase that percentage to 15 or 25 percent, as a measure to help reduce the impact on the Potomac fishery. With that I'm finished. Again, I think the Potomac population is recovering. I thank you for this assessment, and for ongoing and future American shad restoration efforts, which are sorely needed. Thank you.

CHAIRMAN ARMSTRONG: Any more public questions, Toni?

MS. KERNS: We have one last question from the public, Des Kahn.

MR. DESMOND M. KAHN: I appreciate the chance to pop this question. I'm going to start with a question, and then I'm going to give the rationale. The question is, when if ever will the Commission conduct a serious investigation of the predation impacts of our unprecedented abundance of striped bass on other fisheries, including primarily but not exclusively, shad and river herring? When will that happen?

The Commission has studiously ignored this question, and as an example, in the 2007 America shad assessment, two of the premier, actually the top experts in the world on American shad, which was Dr. Victor Crecco and Tom Savoy of the Connecticut DEP published more peer reviewed papers combined than anyone by far on American shad.

Submitted their report on the Connecticut River, and documented extensively how the formerly booming American shad and blueback herring run up the Connecticut River virtually declined and almost disappeared, at least in the case of herring, as stripe bass rebounded in the 1990s into the 2000s.

They submitted this report as the Connecticut Report. It was suppressed under the former director, it was suppressed. It was retained only as a minority report in the 2007 stock assessment. They have also published a peer reviewed paper to this effect. I believe it was in the Connecticut River (broke up).

Now, the subsequent, I believe to that assessment. Connecticut hired a team from the University of Connecticut to do a diet study on striped bass in the Connecticut River, and Justin Davis, who spoke earlier, was the primary person along with Eric Schultz. They documented by stomach content that the largest 10 percent of striped bass in the Connecticut River were eating adult shad in the spring.

The other 90 percent were eating herring, primarily blueback herring. Now, this does not talk about striped bass predation on juvenile shad. This is just on adults. After that, I was working in 2011 on the stock assessment of the Delaware River. I took Roy's former place on the Delaware River Official Wildlife Coop Committee.

I figured since they saw this in the Connecticut, I would look at the Delaware. I plotted the abundance indices of American shad in the river and striped bass in the waters of the Delaware. My jaw hit the floor. There was an unbelievable negative correlation between the two. In the eighties when bass were in the tanks, American shad in the Delaware River were booming.

Up in Pennsylvania, New Jersey there was a recreational fishery that was very strong. Hundreds of thousands of pounds of American shad were being landed by commercial fishers in Delaware Bay at the same time, and yet when striped bass increased in the nineties, that run declined. When bass peaked in the 2000s, American shad were so low that the managers were alarmed. Since then, when bass have declined some, being that the shad is going up. This chart is in an essay I submitted to the Striped Bass Board.

CHAIRMAN ARMSTRONG: Dan, are you near the end? I'm going to have to stop you. You started with a question, which I imagine is rhetorical.

MR. KAHN: No, the question was. (Broke up) That's my question. What?

CHAIRMAN ARMSTRONG: As you well know, there isn't an answer. We don't know that. But we heard from both Karin and Mike time and time again what can be put in as environmental effects, and they talk

about it. Your point is not lost at all. I don't think this is the time, we don't have time to talk about it. But I appreciate you raising it, and it's absolutely an important point. Thank you, Des. Toni, are we done with the public?

MS. KERNS: We have one member of the public that had not asked a question yet, and now he has taken his hand down. There it is, his hand is back up. This would be the last question from the public. Seth Amgott.

CHAIRMAN ARMSTRONG: I know this is probably about the Potomac. If it's redundant to what Jim's very eloquent talk, could you keep it maybe very short, because we're really behind at this point?

MR. SETH AMGOTT: Yes, Mr. Chairman. Thank you for your time. I just wanted to thank the staff for tremendous and impressive work. I particularly appreciate highlighting Jeff Kipps work on the Potomac model, and highlighting the impact of the brood stock removals. It seems to me that advocates and anglers like myself have some work to do with our representatives on the Council in that regard, and making sure that those removal programs are the high-quality programs that they should be, given that they are accounting for mortality.

I do support a limited recreational harvest of American shad. We have work to do until DC and the PRFC come to you with that proposal. Until then, thank you very much for the assessment. I did promise to be brief. Thoreau wrote in 1845 of the effect of dams on the anadromous fish. Who hears the fishes when they cry? Thank you for hearing.

CONSIDER ACCEPTANCE OF BENCHMARK STOCK ASSESSMENT AND PEER REVIEW REPORT FOR MANAGEMENT USE

CHAIRMAN ARMSTRONG: Going back to the Board. We're now considering acceptance of the assessment and the review, and we sort of meshed. The comments have been to that. We can take some more comments on the relative merits of accepting it or not. But I would like to get a motion if I could, to accept the assessment and the peer review for management use. Would someone like to make that motion?

MS. KERNS: You have Pat Keliher.

CHAIRMAN ARMSTRONG: Pat, are you making that motion?

MR. PATRICK C. KELIHER: I would be happy to, Mr. Chairman. I would move that we accept the Benchmark Stock Assessment and Peer Review for management use.

CHAIRMAN ARMSTRONG: Thank you, do we have a second?

MS. KERNS: You do, Cheri Patterson.

CHAIRAMN ARMSTRONG: Cheri Patterson seconds, excellent. Pat and Cheri, I'm guessing you don't need to justify why you did that. Any discussion on this? Any hands, Toni?

MS. KERNS: No hands.

CHAIRMAN ARMSTRONG: No hands, so it would always be easier in this format to do it by consensus. Is there anyone who would vote against this, and do we need to caucus? Any hands, Toni?

MS. KERNS: No hands.

CHAIRMAN ARMSTRONG: All right, seeing none I am going to declare this motion accepted by consensus. All right excellent, and thank you all involved, the Review Committee and the Assessment Committee, awesome work.

CONSIDER MANAGEMENT RESPONSE TO THE ASSESSMENT AND PEER REVIEW

CHAIRMAN ARMSTRONG: We've got a lot of work to digest this and move on with the responses to it, which is the next agenda item. Clearly in my mind we don't have enough information, nor enough time to craft specific responses by this Board to what's in that.

What I would like to do is consider charging the Technical Committee with coming up with a suite of responses, and these could be for individual stocks that are not sustainable or depleted, or coastwide actions also that could relate to improving data collection, et cetera, et cetera. Caitlin, could you help me out here? Is that appropriate to charge the Technical Committee?

MS. KERNS: Mike, I just wanted to let you know Pat Keliher has his hand up.

CHAIRMAN ARMSTRONG: Pat, would you like to weigh in?

MR. KELIHER: I agree, it is really tough at this late hour of the meeting to get into a lot of details, but I do think it would be appropriate to task the TC and the PDT with identifying potential paths forward. If it pleases the Chairman, I would be happy to make that motion.

CHAIRMAN ARMSTRONG: It pleases me immensely.

MR. KELIHER: With that, Mr. Chairman, I would move to task the TC and the PDT with identifying for the Board potential paths forward, to improve shad stocks, given the results of the stock assessment.

MS. KERNS: I believe Emerson Hasbrouck is seconding that motion.

MR. HASBROUCK: Yes, I'll second it.

MS. MAYA DRZEWICKI: Could you repeat the motion, please?

MR. KELIHER: Sure, task the TC and the PDT with identifying for the Board potential paths forward to improve shad stocks, given the results of the stock assessment.

MS. DRZEWICKI: And who is the second?

CHAIRMAN ARMSTRONG: Emerson, I believe. If not, he is now.

MR. HASBROUCK: Yes.

CHAIRMAN ARMSTRONG: Would either of you like to comment?

MR. KELIHER: I think it's clear from the stock assessment there are a lot of areas of concerns as it pertains to this species. I certainly appreciated the fact that there is an emphasis on habitat, and the need to access habitat. That certainly has been our focus here in the state of Maine, and we're seeing the benefits of that work. I think it's time to kind of roll our sleeves up when it comes to the species, and really start to look at what we can do to make some additional changes going forward.

MS. KERNS: Mike, you have Emerson and then Roy Miller.

CHAIRMAN ARMSTRONG: Okay, Emerson.

MR. HASBROUCK: I thought my hand was down. My hand was up to second the motion. I don't have anything to add beyond what Pat has already mentioned.

CHAIRMAN ARMSTRONG: Roy Miller.

MR. MILLER: For the maker and seconder of the motion. I just wanted to clarify that that advice to the TC and PDT, is that with the assumption that they will be making river-specific recommendations for paths forward, rather than a generic list of things that can be done? Because the river-specific recommendations would be much more helpful, and that is sort of obvious, but I wanted to make sure that that was the intent of the maker of the motion.

CHAIRMAN ARMSTRONG: I would think it is, but do you want to refine it to reflect that?

MR. KELIHER: That certainly was my intent, Mr. Chairman, but I didn't go into that level of specificity, in case there are some other areas within management that need to be looked at, kind of from a

regional aspect as well. I left it a little bit broad to give them some flexibility.

CHAIRMAN ARMSTRONG: Sure.

MR. KELIHER: I completely agree with Roy's thinking around river specific. If we're not really having some detailed focused efforts on a river by river basis, we're never going to get to the point we need to with this species.

CHAIRMAN ARMSTRONG: Right, but there also may be some coastwide things, you know like the need to move to otoliths and things like that we need to capture also. Toni, do you think this is specific enough? Toni and or Mike Bailey, or Caitlin.

MS. CAITLIN STARKS: Yes, this is Caitlin. I think that this is clear enough that the Technical Committee, so we normally don't have the PDT unless an action is initiated, so I guess you could start with the Technical Committee developing some recommendation, and depending on those recommendations move forward with a PDT looking at them. Does that sound appropriate?

CHAIRMAN ARMSTRONG: We would have to meet again before we task the PDT, is that correct?

MS. KERNS: Correct. It would be TC and staff that you would identify potential paths forward, but usually just the TC. You broke up a little right there, Mike.

CHAIRMAN ARMSTRONG: I said would it be better if Pat perfects this motion and gets rid of the PDT in it?

MR. KELIHER: Sure.

MS. KERNS: Maya, please delete and the PDT. Thank you.
CHAIRMAN ARMSTRONG: The motion is, move to task the TC with identifying for the Board potential paths forward to improve shad stocks given the results of the stock assessment. I've heard that that is sufficient to cover Roy's concerns, and maybe some of my concerns, broad based things that we could conserve. Comments on the motion.

MS. KERNS: You have Lynn Fegley.

CHAIRMAN ARMSTRONG: Lynn, go ahead.

MS. LYNN FEGLEY: I just wanted to clarify that this is different from the research recommendations that are thoroughly listed in the assessment reports. I don't know if this needs to be specified in the motion, but I'm assuming this is really paths forward, in terms of functional management items.

Rather than things that could be done to improve our state of knowledge, which is a path forward for improving the stocks. I just want to make sure we're delineating, kind of for the Technical Committee, sort of researched study work that needs to be done from a management path forward.

CHAIRMAN ARMSTRONG: It's more complicated than it sounds. I think the former. This is, we're looking for management actions that need to be done, but I think if the TC identifies a research need, like all states move to using otoliths for aging. Then that could be put into an addendum or some sort of action as we see fit. I think it's geared, and staff can correct me. I think it's geared towards management actions that we can take to address issues in assessment. Does that answer your question, Lynn?

MS. FEGLEY: Yes, it does, thank you.

CHAIRMAN ARMSTRONG: Any other hands, Toni?

MS. KERNS: Those were all your hands from the Board. There is one member of the public that has had their hand up.

CHAIRMAN ARMSTRONG: Okay, I'm not going to take any public comment at this point. I think we're going to move to see if this is by consensus, we can approve this. Is anyone opposed to this motion?

MS. KERNS: I do not see any hands.

CHAIRMAN ARMSTRONG: Seeing none, this motion passes by consensus. At this point, well we're scheduled for a break, and could we take a five minute, literally just five minutes for a biological break, and start again at 11:15.

MS. KERNS: Sounds good, Mike.

(Whereas a recess was taken.)

CONSIDER STATE PROPOSALS TO RESOLVE INCONSISTENCIES WITH AMENDMENTS 2 AND 3

CHAIRMAN ARMSTRONG: Toni, are we ready to resume?

MS. KERNS: Sure are, thanks, Mike.

CHAIRMAN ARMSTRONG: All right, looking at the radar image I see New Jersey and Delaware, you are in the belly of the beast right now. I think we've lost a few people off the line.

PRESENTATION OF STATE PROPOSALS AND TECHNICAL COMMITTEE RECOMMENDAITONS

CHAIRMAN ARMSTRONG: The next is the Technical Committee Review of the State Proposals to Resolve Inconsistencies with Amendment 2 and 3, and that will be presented by Ken Sprankle, he's the TC Chair. Go ahead, Ken.

MR. KEN SPRANKLE: Okay, thank you, Mr. Chairman. Good morning everyone. This presentation this morning will be shared by Caitlin and myself. I'm going to start by covering the Board charges, the TCs work and approach on those, and the TCs recommendations. Caitlin will cover later on how the TC recommendations relate to the existing FMPs for both shad and river herring, to help with any discussion.

Our presentation is going to start with some background information; the TCs recommendations. Those had been presented originally back at the October 2019 Board meeting. We'll follow that by the TC review of the state proposals that were directed for development by the Board. Those are going to include plans for Maine, New Hampshire, the Delaware River Basin Cooperative, the state of Delaware, North Carolina, South Carolina, Georgia and Florida. We've got a lot to cover, we'll cover them quickly, but hopefully thoroughly. The Board can then decide on actions, and we'll end with remaining tasks for the TC. I'm just going to remind folks, as many are aware that both Amendments 2 and 3 require all states and jurisdictions to submit sustainable fish management plans for all systems that remain open to river herring and shad harvest, either recreational or commercial.

The catch and release fishing can be permitted on any river without an SFMP. In the amendments they state that specifically SFMPs must demonstrate fisheries are sustainable with quantifiable sustainability metrics and annual monitoring. Sustainability is defined as, will not diminish future stock reproduction and recruitment.

I want to also note that both amendments also describe an alternative management regime option that may be proposed for Board approval. That is further defined as, if the proposal has the same conservation values that the measures contained within the amendment. In October 2017, the TC identified inconsistencies between state management programs and FMP requirements for both Amendment 2 and 3.

The Board then tasked the TC to develop recommendations to address them. Some examples of these inconsistencies included tributaries or river systems that have SFMPs and monitoring, but where tributaries are not explicitly addressed. Second, rivers open to harvest in an SFMP, but with no monitoring to address sustainability, and lastly the third one, rivers open to harvest without an SFMP and/or monitoring, but where little to no harvest is suspected.

Again, in October 2019, the TC presented a report on these inconsistencies, and recommendations for resolving each issue. At that Board meeting the TC was requested to have the states submit proposals to resolve inconsistencies consistent with the TC recommendations. The TCs recommendations for these inconsistencies included three options.

The first one I have shown here is catch and release only regulations. Those are for systems with no plans that appear to have the most clear-cut option, and it was also sustainable, of course. Catch and release regulations have been implemented by most states without SFMP metrics. Another option would be application of sustainability metrics for monitored systems, and that is where sustainability metrics can be applied to a broader geographic area for unmonitored areas.

The Amendments speak to the fact that state wide and metrics may be used. Lastly, we have the alternative management regimes that I mentioned. The TC considered this option may be appropriate for systems with no known harvest. I'm going to review now some of the summarized elements of the proposed individual state plans.

The state of Maine has an existing approved river herring SFMP. The issue was the state wide 25 fish recreational bag limit, with limited monitoring. The state proposal includes updating the SFMP to manage all rivers in a region based on fish weight counts as a sustainability metric from five fishways across the state.

Those fishways include the first, these are all first. The Saco River, Androscoggin, Kennebec, Penobscot and St. Croix. For folks not familiar with Maine, that is spanning sort of south to north in a northward direction across their coastal river systems. The 25th percentile, the fishway count mean will be used for each fishway as a management benchmark trigger. That is for each fishway, with management actions applied on a regional basis, just based upon the geographic area located between neighboring monitored areas, if the metric falls under the 25th percentile for three consecutive years.

The mean annual count of all fishways will also be used, with the 25th percentile benchmark trigger, and that is also a three-year consecutive basis. If that was tripped that would cause a statewide management action. The TCs recommendation is support approval of this SFMP update.

The state of Maine currently has no approved SFMP for America shad. The issue is a statewide 2 fish recreational bag limit. The state has proposed a new American shad SFMP that will use statewide applied sustainability metrics based on annual fishway counts from five fishways, and also a JAI value for the Merrymeeting Bay.

Merrymeeting Bay covers Kennebec and Androscoggin, two major river systems flow into it. The five fishways that are used, also sorting out south to north will be the Saco, Androscoggin, Kennebec, Sebasticook, and the Penobscot Rivers. Again, the 25th percentile value from the data time series is going to serve as the trigger for the JAI, and also for the individual fishway annual passage counts.

Three consecutive years below the 25th percentile will trigger a management response. Because they have both fishway counts and the JAI, if only one of the data types, either JAI or one or more of the fish counts meet the trigger, the recreational limit would be reduced to 1 fish. If both the JAI and one or more fish ways are below the trigger for three consecutive years, then the action would be to move to catch and release only. The Technical Committee recommendation is support of approval of the new SFMP.

The state of New Hampshire has an approved river herring SFMP. The issue was a lack of monitoring on the Salmon Falls River. That is a shared waterbody with the state of Maine. The state has proposed to update the SFMP with language that identified the Salmon Falls River as included in the existing Great Day Sustainability Metric, with the same subsequent management actions applied based on triggers.

We're going to talk about those in a moment. The TC recommendation is support of approval of the updated SFMP. We also learned back in the early spring the state of New Hampshire had a concern with the compliance, based on their defined management action from a trigger sustainability metric.

The management threshold for their river herring SFMP is 75,450 river herring passed among their Great Bay monitored fishways. That was not reached in 2019, which should trigger a closure for 2020. Back in the spring the state provided the Board with a letter, and also discussed with the TC the issues surrounding reaching that trigger.

Cheri Patterson, again submitted a letter, it's dated April 7, about how they fell under the three-year running average that would trigger the benchmark management action, and the issues associated with that. As I said, Mike Dionne, he's a TC member from New Hampshire, he met with the TC, and we discussed that there are several different causes for that, including some concerns with the multi-tool fish counter, low water temperatures, and a dam removal and habitat use occurring downstream of one of the fishways.

The New Hampshire River Herring Plan states that if the three-year running average benchmark of the Great Day Fishways fall below the threshold, they institute a fishery closure. In April that letter again requested the fishery remain open in 2020, given their explanation of the issues and plans to take steps to address them.

The TC recommendation based upon that original letter was to support the approach of requesting Board exemption from their SFMP benchmark trigger, given the variables impacting the counts in 2019 for the 2020 season. Now Caitlin and I also communicated with New Hampshire Fish and Game for an update, and Cheri Patterson has recently submitted a letter to the Board. That letter is dated 7/30, has not been reviewed by the TC.

The recent letter to the Board restates the request for the 2020 fishery to be open, with a planned closure for the fishery in 2021, due to the second year of being below their threshold trigger, based upon 2021 count data. The Delaware River Cooperative has an approved shad SFMP. The issue was tributaries that were not identified in the plan.

The Co-op plan has been revised to identify tidal reaches of rivers in both New Jersey and Delaware, and the Technical Committee recommendation is to support the proposed revision to clarify its system tributaries in the plan. The state of Delaware does not have a state-specific SFMP plan for shad.

They also have an issue with allowing recreational harvest in tributaries to the Chesapeake Bay. The Delaware proposal is to implement catch and release regulations for all Chesapeake Bay tributaries, which is expected to be processed by end of this calendar year. The TC recommendation is support approval with the regulatory changes consistent with Amendment 3. The state of North Carolina has an approved shad SFMP.

The issues were tributaries that are not included in the plan, and also no monitoring and no SFMP for the Little River, which is a shared waterbody with the state of South Carolina. The states revised their SFMP to identify, incorporate tributaries in the SFMP, and also include the Little River, stating that system will be managed consistent with the South Carolina SFMP that includes that system in the Winyah Bay for its sustainability metrics and management actions.

The TC recommendation is to support approval of the proposed SFMP update. The state of South Carolina has an approved river herring sustainable fish management plan. The issues for the river herring include tributaries of open systems not identified in the SFMP, and recreational harvest that is open in systems without an SFMP.

That includes the Little River, Wando, Ashely, the ACE Basin, Coosawhatchie, and the Savannah River. The state proposal is to update the SFMP to include the tributaries of monitored systems, and those include updates to all the tributaries of the Winyah Bay in the Santee-Cooper system are identified, and the Little River will utilize the PD metric and management response. In addition, the state proposes to use an alternative management plan for unmonitored systems that are open to recreational harvest. Those

systems include the Wando, Ashely, ACE Basin, Coosawhatchie, and Savanna River.

I'm just going to note here that we have three South Carolina plans to summarize here, so the TC recommendations are going to follow after we cover all of these. The South Carolina Alternative Management Plan includes the ACE Basin and the Coosawhatchie and Savannah Rivers. The plan describes that South Carolina is unaware of any recreational fishing for river herring in these systems,that includes using MRIP data.

Commercial fishing is not allowed in any of those waters. Their plan describes river herring as functionally absent in these areas, and provides data from fishery independent surveys that include two shad young of the year electrofishing surveys, that are annually conducted in both the Edisto and Savannah Rivers.

The plan notes that a total of 28 juvenile blueback herring have been collected over 10 years of these surveys. The plan also notes that Georgia DNR has a 10-year spring adult shad electrofishing survey that is conducted below the first barrier on the Savannah River that also supports their position.

Their plan includes changes to regulations or development of an SFMP. If any survey detects a positive recreational harvest for three consecutive years, positive was defined as the most conservative. That would just be a single observation for count. They also note the fishery independent and fishery dependent surveys are also planned to continue, and the annual survey results are to be reported in the annual compliance report.

Lastly, the state of South Carolina has an approved shad SFMP. The issue is that tributaries are monitored systems, and are not included in the SFMP. The state proposes to link tributaries to monitored systems with sustainability metrics, and the system definitions are consistent with those in the river herring SFMP.

The TC recommends supporting approval of all three South Carolina proposals, the River Herring SFMP Update, the River Herring Alternative Management Plan, and I'll remind you again that that includes the TC request that all available monitoring data mentioned in the plan are to be submitted annually with the compliance reports. Then lastly, it recommends approval of the Shad SFMP Update as well.

The state of Georgia has an approved shad SFMP. The issues are unmonitored river systems in the plan, and the sustainability metric for the Savannah River, which is no longer considered viable by Georgia. The Georgia SFMP proposal updates the tributaries that are covered by systems, and it also applies the Altamaha metric and benchmark to other systems with insufficient data, specifically the St. Mary and Satilla Rivers.

Only the Altamaha and Savannah River allow both recreational and commercial fisheries. The other systems are recreational only. The Savannah River has had its commercial shad fishery decline consistently, to the point where the use of commercial netters sustainability metric is unreliable. The Georgia proposal is to use an ongoing ten-year fishery independent spring electrofishing survey. For adult shad it's conducted below the Army Corp Bluff Lock and Dam facility. Georgia proposes to use the annual CPUE data, relative to a 25th percentile value for the data time series of benchmark trigger.

That would trigger management action if below for three consecutive years. The Altamaha sustainability measure is a Georgia fishery independent gillnet CPUE with a benchmark trigger of three consecutive years falling below the 25th percentile. The TC recommendation is to support approval. The state of Georgia has no SFMP for river herring.

Commercial fishing for river herring is not allowed, but recreational fishing is unregulated. The state proposes an alternative management plan for systems statewide that would maintain no commercial fishing, and for recreational fisheries to remain unregulated.

State plan notes that there are no landings records for river herring, and there is no known directed recreational effort for river herring.

The plan describes river herring as functionally absent from systems, and provides data available from both fishery independent and fishery dependent surveys. In Amendment 2, under monitoring table requirements, Table 15 and 16, it states; there are currently no known river herring populations in Georgia.

Should populations be established, the management board has the authority to require a fisheries independent monitoring program be implemented. That was from one of the tables, the other one of course would speak to fishery dependent monitoring. Some examples of some of the data that were cited included DNR annual creel surveys in the Altamaha, and that is a survey that is conducted from April through November that has shown no records for river herring harvest.

On the Ogeechee a creel survey is conducted every five years, and that occurs from February to June, also no records shown there. They've also looked at MRIP data that shows no harvest records as well. In terms of fishery independent data, that includes the Savannah River adult spring shad fishing survey I just mentioned.

That survey has produced a total of three reported river herring over the data time series. The plan also sites a spring electrofishing survey in the Ogeechee for adult shad. It has not observed any river herring. Other rivers in the state have rotational electrofishing surveys that have not observed any river herring.

They have juvenile index seine surveys for shad that are also conducted from July to September in the Ogeechee, Altamaha and Savannah River, and they've had limited river herring captures. Since 2011, a total of 13,300 juvenile shad have been collected in those surveys, with a total of 267 blueback herring captured in those surveys as well.

The proposal notes Georgia will continue with the described fishery independent and fishery dependent surveys, and they will provide data for monitoring in their annual compliance reports. If they detect any positive recreational harvest in any survey in any single year, they will investigate to see if additional data collection is warranted. If a positive harvest is detected for three consecutive years, Georgia will take steps to ensure sustainability for that river system. They note in the plan that no fishery independent data will be used at this time as part of their plan. The TC recommendation is support approval with annual monitoring data provided in compliance reports.

The state of Florida has a shad SFMP. The issue include that the tributaries of the St. Johns River were not identified. The St. Johns is the only system identified in the SFMP, although there are statewide Alosa recreational harvest regulations. The state proposed to update the shad SFMP and include the tributaries of the St. Johns, and a TC recommendation is support approval of this update.

Florida proposes an alternative management plan to address the potential recreational harvest of river herring statewide, and shad outside of the St. Johns River. The issue is again a statewide 10 fish recreational limit on Alosa species, with no SFMP for river herring or shad outside of the St. Johns River.

The proposal is an alternative management plan that will maintain existing regulations. The plan reviews the lack of any credible data reports for any river herring or shad harvest outside of the St. Johns River. There are also no fishery independent data to support river herring or shad occurrence outside of the St. Johns River Basin.

The alternative management plan will continue to examine and monitor both shad and river herring, both fishery independent and fishery dependent surveys in the St. Johns, and Florida will coordinate with Georgia for any survey data for the St. Mary's River, a shared water body. Florida will also monitor MRIP data for both species.

If any positive harvest detection occurs for three consecutive years, Florida will initiate a process to demonstrate sustainability for that system. If it

cannot, regulatory changes will be enacted. The TC recommendation is support approval, and as with the other alternative management plans, any monitoring data for these species in any system will be provided annually in a compliance report. With that I'm going to let Caitlin take over, and she will cover these remaining slides.

MS. CAITLIN STARKS: Thanks, Ken. I switched the order of the slides a little bit from the overview, so sorry if that was confusing. But before we get into what the Board actions are to be considered today, I did want to go over what the TC is up to, in terms of developing recommendations for the remaining items from the original Board task related to improving Amendments 2 and 3, in the five areas that are listed on this slide.

The current plan is that the Technical Committee had formed a subgroup, which is a smaller task group that is focusing on developing draft recommendations, and they are continuing to meet, and will present those draft recommendations to the full TC. Then the TC will finalize recommendations to be presented to the Board at a future meeting. You'll note here that the de minimis issue is crossed off, because it's already been resolved. That was presented at the last meeting. Those remaining four items are what the TC will be developing recommendations are, in terms of potential modifications to the FMP to help with some of these issues. In terms of the Board action for consideration related to this agenda item. Today the Board may consider approval of the state proposals that were presented, and secondly consider approval of the request from New Hampshire for an exemption to their SFMP requirement to close their river herring fishery in 2020.

Despite having fallen below that sustainability threshold, which again they assert is due to technical issues with their fish count, and other explanatory variables, rather than true fish passage concerns. To help with the first Board action related to approving the state proposals. This table is summarizing all of the proposals that were submitted from each state that we've gone over today.

I highlighted in bold the proposals for the alternative management plans from South Carolina, Georgia, and Florida. Just because I think the Board may want to have as kind of separate, or focus discussion on these, since they're a bit different from what we are used to with the SFMPs. This is my last slide before questions and Board discussion.

But I think it would be helpful to give a reminder of what Amendment 2 provides, in terms of guidance on the alternative management regime for Alternative Management Plans. Amendment 2 says that these plans must demonstrate that the proposed management program will not contribute to overfishing of the resource, or inhibit restoration of the resource, and that they must show to the Board's satisfaction that the alternative proposal will have the same conservation value as the measures in Amendment 2.

That to me seems to reference the requirement to implement catch and release only regulations, in the absence of assisting a whole fishery management plan. When the Board is considering the three alternative plans today, I think an important question to keep in mind is, does the plan meet these two criteria or not. That is the end of our presentation, and Ken and I can take any questions.

CHAIRMAN ARMSTRONG: Any questions from the Board, Toni?

MS. KERNS: None I see yet.

CHAIRMAN ARMSTRONG: Based on Caitlin's advice, I think we probably have three motions we would like to make, just so we can have a little bit of discussion on each, and one is a motion to accept the sustainable fishery management plans and any amendments.

They made one motion to approve the alternative management plans, and then consider the request by New Hampshire separately, of which I think Cheri has a motion. Any broad questions? I don't think at this point any state has to defend what they've put out,

unless they are attacked, of course, which you know may happen. Toni, seeing any questions?

MS. KERNS: No hands are raised.

CHAIRMAN ARMSTRONG: Would someone like to make a motion to accept?
MS. KERNS: Chris Batsavage did just throw up his hand. I'm not sure if it's for a motion or a question.

CHAIRMAN ARMSTRONG: I'm sorry, who was that?

MS. KERNS: Chris Batsavage.

CHAIRMAN ARMSTRONG: Chris Batsavage, go ahead.

MR. CHRIS BATSAVAGE: Actually, a question on the Alternative Management Plans, questions for Ken. If I understand correctly, the South Carolina and Georgia mainly, and I guess Florida too will be looking at a recreational survey such as MRIP, and other creel surveys to detect any positive harvest over a three-year period, to see if they need action.

Was there any discussion by the TC over river herring being a very rare event species in any of these surveys, so they may not pick up any positive harvest, and also that MRIP doesn't cover the range of where river herring might be harvested by recreational fisheries in these rivers?

MR. SPRANKLE: Hi, thanks for your question. Yes, we certainly did discuss this thing. As you pointed out, the MRIP geographic range is limited to a couple areas. Folks are acutely aware of that. In terms of the recreational creel surveys, we didn't get into specifically what their creel clerks are asking.

I guess the assumption was that as a creel survey they would be detecting whatever was angled, what species were angled. You know again, the limitations of MRIP were understood, and then depending on which state you're talking about, there were other additional roving surveys that I mentioned for some of the states that occurred, that they felt would provide some ability to detect a positive occurrence.

CHAIRMAN ARMSTRONG: Okay, does that answer your question, Chris?

MR. BATSAVAGE: Yes, that will work, thanks.

ADVISORY PANEL REPORT

MS. STARKS: This is Caitlin, I would just like to cut in one second, Mike. Before we take motions and we continue with questions, but **we do have an AP Report that needs to be presented, so just letting you know.**

CHAIRMAN ARMSTRONG: All right, so why don't we move right into that.

MS. PAM LYONS GROMEN: Okay Caitlin, this is Pam. Should I go?

MS. STARKS: I think you're all set.

MS. GROMEN: Thank you, Mr. Chairman, members of the Board. It's a pleasure to be with you, albeit virtually. It's been a while since we've had an AP meeting, so I'm glad to present our report today. Our Advisory Panel met via webinar and conference call on April 8, to review the state proposals for resolving the inconsistencies with Amendments 2 and 3. Materials that we used for our meeting is we had a March 17 memo summarizing the state proposals, and the TC recommendations. Also, we were given well in advance of our webinar the proposals submitted by Maine, New Hampshire, Delaware, North Carolina, South Carolina, Georgia, and Florida, and we were sent those again electronically, so we had plenty of time to review those.

We had six AP members attend the webinar, representing Maine, Massachusetts, New York, New Jersey and North Carolina. I'll just say that six actually represents 50 percent of our AP membership, and so we do have some states where we do not have representation currently on the Advisory Panel.

Since I have the microphone, I'll just do a plug for getting some representatives to join our panel. Then the AP did provide comments on the individual state proposals, and also the TC recommendations regarding the additional improvements to the FMP. There was general agreement among the AP members to support the TC recommendations for approving both the state plans and the FMP. Seems to be somebody needing to mute there.

There was general agreement among the AP members to support the TC recommendations for improving both the state plans and the FMP as a whole. A question was raised about whether catch and release mortality rate estimates are available, as this is certainly important to consider if we're encouraging catch and release of recreational fisheries without a sustainable fishery management plan.

There was one member who expressed concern about the South Carolina plan, and why there was not data available in the proposal we saw after 2015. Since then there was additional communications that explained that that has to do with the sustainability metric that's used. We understood that, but just would have like to have seen more recent data.

Then for Georgia and Florida there was a concern raised by an AP member that the aggregate creel limits may pose issues, because the Alosa species are not easy to distinguish, and that education should be provided to anglers to differentiate between the species. The Alternative Management Plans or regimes, as discussed earlier they actually sparked a pretty robust discussion among our AP.

Again, these are alternative management programs are for rivers or river systems without a sustainable fishery management program. But they are not requiring catch and release for recreational fisheries. This is primarily for river herring. One member felt that rather than moratoriums for rivers without sustainable fishery management plans, a small personal harvest should be permitted for recreational fishermen.

Another member added that he would be in favor of this if it was biologically possible. Other AP members were concerned that the alternative management programs were not consistent with the goals of management, or fair to other states that have implemented required catch and release regulations, and as one member summarized, the idea of the fisheries being open, unmanaged, and uncounted seems problematic. Our AP member from New York relayed that fishermen in his state understood the closures, because they were concerned about the resource. There is a need to rebuild before we consider how many fish people should be allowed to take. Our AP member from Maine explained how they are leveraging the desire of some communities to take fish in order to restore the resource. He said the TC could recommend that some fisheries be reopened if more data is collected, and that this could fill data gaps along the coast. This led to just some general overarching comments. There is a connection between personal harvest and stewardship that should be recognized, and this was a big theme of our discussion.

Historically, shad and river herring were culturally important, and people took care of their runs, because the runs generated food, jobs, and revenue for the towns. The generation that used to eat river herring is dying out, and the focus has shifted to protecting river herring as part of the food chain for other species, and that it's certainly recognized as an important benefit.

But I think the point was made, because it's a more removed benefit than the personal experience of capturing a fish and handling it. Then our goals should be to bring river herring and shad populations back to a place where they can be harvested and serve their role in the ecosystem. The ASMFC has a duty to incentivize more data collection for river herring, and reconnect people with fish through education and citizen science.

Then finally, additional guidance on the Alternative Management Plans could be more specific on incentivizing data collection, in exchange for providing for a low level of personal harvest. I believe that

concludes our comments from the AP. I would just mention that our full report is behind the supplemental materials.

CHAIRMAN ARMSTRONG: Thank you, Pam. Are there any questions from the Board for Pam? Toni, any hands?

MS. KERNS: No, no questions yet.

MS. STARKS: I see Emerson's hand up, or maybe not anymore.

CHAIRMAN ARMSTRONG: Emerson, did you have a comment?

MR. HASBROUCK: I was going to make a motion to accept the management plans when you're ready for that motion.

CHAIRMAN ARMSTRONG: Okay. Caitlin, the motion that started to be up there. Would that cover the Alternative Plans and the Sustainable Fishery Plans?

CONSIDER APPROVAL OF STATE PROPOSALS

MS. STARKS: I think it would need to be made a little more specific, if you wanted it to only cover the SFMP and state proposals that were not Alternative Plans. This I think could cover all of them. If there is a desire to do that separately, I think that this would have to be modified.

CHAIRMAN ARMSTRONG: Why don't we leave it broad? I think New Hampshire will handle separately, so this includes the Alternative Plans and the SFMP modifications. Would anyone like to make that motion for discussion?

MS. KERNS: Lynn Fegley has her hand raised.

CHAIRMAN ARMSTRONG: Lynn, you are making that motion, thank you Lynn Fegley.

MS. KERNS: And Spud Woodward has his hand up as the seconder, I believe.

CHAIRMAN ARMSTRONG: Excellent, seconded by Spud Woodward. Then Emerson I think has his hand up for a question, maybe, or a comment?

CHAIRMAN ARMSTRONG: Okay, go ahead.

MR. HASBROUCK: No, I had my hand up, and as I mentioned before, I was ready to make that motion when the Chair was ready.

CHAIRMAN ARMSTRONG: Right, I'm sorry.

MR. HASBROUCK: It's already been made and seconded, so I'm fine.

CHAIRMAN ARMSTRONG: That's my fault, Emerson. Anyway, any discussion, would Lynn or Spud need to say anything about this?

MS. FEGLEY: No discussion from me, thank you.

MS. KERNS: You do have Chris Batsavage.

CHAIRMAN ARMSTRONG: Chris Batsavage, go ahead.

MR. BATSAVAGE: Yes, I think I could support the motion for approving all of these. I just want to raise my concerns for just how the Alternative Management Plans, a plan is written in the amendment. I think the AP brought up some good points, as far as it's not really a level playing field for states that have SFMPs, and do the monitoring to make sure their fisheries are sustainable, and don't open fisheries that they don't have the available data.

It almost incentivizes states not to collect as much information, quite frankly. When you consider that river herring is always just a few steps away from potentially being listed as threatened or endangered on the endangered species list, I think I would hope that the TC and PDT works to kind of firm up what is allowed in alternative management plans in the future. Thanks.

CHAIRMAN ARMSTRONG: Thank you, Chris, good comment. Any other comments?

MS. KERNS: We have Megan Ware, and then Emerson, your hand is still up, so I'm not sure if that is left over from before or not.

CHAIRMAN ARMSTRONG: Megan, go ahead.

MS. MEGAN WARE: I think it would just be helpful for me if one of the states with the Adaptive Management Plans could just speak a little bit to the development of that and why they didn't go with catch and release. I mean if there doesn't appear to be recreational harvest now, I'm just trying to understand the state's thought process. I think that might be helpful.

MS. KERNS: You have Spud Woodward with his hand up, Mr. Chairman.

CHAIRMAN ARMSTRONG: Go ahead, Spud.

MR. A.G. "SPUD" WOODWARD: Yes, I can speak to Georgia's approach on this. You know I've said this before in Board meetings that when we go, the four decision making bodies at our respective states and do things on behalf of the Commission. It's always important that they see the necessity and legitimacy of doing it.

If we were to request our Board of Natural Resources to promulgate catch and release regulations for a species that is functionally absent from a river system, then it calls the question, some of what we can do as a Commission. We feel confident that we have data collection processes in place that are going to detect the occurrence of these species, if they do become something other than functionally absent.

We think we're consistent with the spirit of the plan and the intent of the plan, to make sure that we do adequately manage river herring if they do occur with any frequency and abundance, that we will catch that in our data collection process. We have roving crew surveys independent of MRIP, so we're covering the possible range of distribution of these species in these river systems. That is just the Georgia perspective.

CHAIRMAN ARMSTRONG: Thank you, Spud, are there any other Alternative Plans who would want to comment?

MS. KERNS: I don't see any hands raised.

CHAIRMAN ARMSTRONG: Any other questions, comments on the motion?

MS. KERNS: I do not see any hands.

CHAIRMAN ARMSTRONG: All right, again we'll try for consensus. Are there any no votes?

MS. KERNS: I don't see any hands for no votes.

CHAIRMAN ARMSTRONG: All right, seeing none, you will consider the motion passed by consensus. I think we need to address New Hampshire's exemption, Cheri, do you have a motion?

MS. PATTERSON: Yes, I do, thank you. Can you bring it up, Maya? I move to approve New Hampshire's request for an exemption for their river herring SFMP requirement to close the fishery in 2020 based on data indicating that passage counts for the most recent three-year average did not meet the sustainability target of 72,450 fish. This exemption is based on explanatory information supporting the claim that passage counts are low due to equipment failure and other variables, rather than true fish passage numbers. If I can get a second, I can delve into that further.

CHAIRMAN ARMSTRONG: Is there a second?

MS. KERNS: We have Roy Miller.

CHAIRMAN ARMSTRONG: We have a second by Roy Miller.

MS. PATTERSON: Thank you, Roy. We have been struggling with a couple of our fish passage places in two river systems. One of them we've been trying to modify, in order to address a hydro development facility that continually adjusts the impoundment levels. So far that is not working out really well.

We thought we had it resolved this spring, but due to the flows that really didn't come through this spring, the modifications we made still were not passing the amount of fish that we should be passing in the Cocheco. As for our second river system, we had a dam removal project there, and we were hoping to continue to monitor the fish passage at the next dam and fish ladder.

However, it seems as though the fish that are bypassing, or going through the former dam site are not making it up to the other fish ladder, they're dropping out and doing their spawning below that. We're not getting a really good count of what is going past that former dam site that had a fish ladder where we were accounting for those fish in that river system. The 2020, we had moved this past the TC. They agreed that due to circumstances that they were okay with us not closing the fishery in 2020.

It so happens that it's a moot point now. We didn't close the fishery in 2020. The fishery is done, it pretty much goes from April through June. But based on us still running into problems with these two river systems, and our fish passage counts are still below the sustainability target that we will be closing our season in 2021, in order to be able to thoroughly address our concerns, and get fish up into these system that are low producing at this point in time. Does anybody have any questions?

CHAIRMAN ARMSTRONG: Questions for Cheri, comments. I assume there are none.

MS. FEGLEY: Mr. Chairman, this is Lynn Fegley. I raised my hand. I do have a question.

CHAIRMAN ARMSTRONG: Oh, Toni is completely dropping the ball, sorry. Go ahead, Lynn.

MS. FEGLEY: No, that is fine. Cheri, just so that I'm clear and I didn't miss it. The 2020 fishery, which is what this motion is about is already essentially over, and you are planning on closing the fishery in 2021. Is that correct?

MS. PATTERSON: That is correct.

MS. FEGLEY: Awesome, thank you.

CHAIRMAN ARMSTRONG: I guess we'll move the motion. We'll try to do it by consensus. Are there any objections to the motion?

MS. KERNS: I do not see any hand raised in objection.

CHAIRMAN ARMSTRONG: Thank you, then the motion passes by consensus.

MS. PATTERSON: Thank you very much.

CHAIRMAN ARMSTRONG: I think we have the major items done. We just have a couple of short updates and elect a Vice-Chair. We're going to stay the course. It will probably take ten or fifteen more minutes. Thank you for all your forbearance.

UPDATE ON RIVER HERRING TECHNICAL EXPERT WORK GROUP ACTIVITIES

CHAIRMAN ARMSTRONG: Caitlin, could you update us on the TEWG?

MS. STARKS: Yes, I can. Can everyone see my screen now?

CHAIRMAN ARMSTRONG: Yes.

MS. STARKS: These will be very fast, I just have one quick update on the TEWG, well two quick updates on the TEWG, and then a quick update on Shad Habitat Management Plan. For the TEWG, I just want to give a little bit of background, since you haven't discussed it in a while. But this group was formed in 2014, as a joint effort between NOAA Fisheries and ASMFC, and it was kind of in response to the 2013 determination that was seeing river herring under the ESA was not warranted.

When that determination was made, the two bodies agreed to develop a long-term dynamic conservation

plan for river herring, and formed the TEWG with the purpose of informing that conservation plan, and identifying the critical data gaps and research needs that are hindering river herring recovery.

The TEWG produced a few white papers, focusing on different areas like river herring genetics, climate change impacts, fisheries, et cetera, and those were supposed to serve as the foundation for the conservation plan. That plan was considered completed in 2015, but it didn't exactly realize what the vision was, which was kind of a comprehensive document synthesizing all of that information into one place.

After producing those white papers, which were put online on a web format, the TEWG working group and subgroup kind of stalled, without having a real clear purpose or deliverable to produce. But the group as a whole has continued meeting twice a year, and these meetings have kind of transitioned from a work focus to more of an information exchange format among river herring experts. Over the last several meetings we've gotten a sense from the participants that there is still an interest in having a more actionable document to guide river herring conservation efforts along the coast. Fortunately, NOAA Fisheries has recently secured some funding to have a contractor go back and try to update and rework that conservation plan from 2015 into something more comprehensive and informative to managers. NOAA Fisheries has outlined the scope of work for this contract, which is supposed to start in early 2021. The project is expected to produce something like that comprehensive document that provides a framework, goals and objectives, for river herring restoration throughout their range, based on expert opinions.

I guess now is a good time to note that we're trying to move away from calling it a conservation plan, because the document would not be requiring the states or NOAA to implement any actions, but would rather provide managers with updated information on the current threats, existing federal and state management actions, data and research needs, and expert recommendations for conservation and restoration efforts aimed at river herring recovery.

In general, the goal of this document would be to promote collaboration of river herring practitioners from different fields, support priority setting, and provide recommended actions for conservation and restoration of river herring throughout the range. That is an update on TEWG work, and then another update is that the coordinators being Sean McDermott from NOAA Fisheries and myself, have discussed changing the name of the group to better reflect the change in function from that workgroup format to more of an information exchange format.

We've had good attendance and positive feedback from participants on this new meeting format, as well as the potential name change. After discussing a few options, we're focusing on the name Atlantic Coast River Herring Collaborative Forum or River Herring Forum for short. Today I just wanted to get the Board's feedback on these two updates, and determine if there is general agreement among the Board members on the focus of the contract work that I described, and the potential renaming of the TEWG.

I'm happy to take questions and comments at this meeting, or I could also have follow-up e-mails if Board members have additional thoughts they would like to add or would like more information on either of these things. I also think NOAA staff discussing with them, they would be open to having a more detailed discussion on the focus and product of the contract work at a future meeting, if there is a desire from the Board. With that I guess I will open it up for questions or any quick comments that folks might have.

CHAIRMAN ARMSTRONG: Questions or comments for Caitlin, keeping in mind that there can be follow up conversations also.

MS. KERNS: Mike, I do not see any hands raised.

UPDATE ON TIMELINE FOR SHAD HABITAT PLAN UPDATES

CHAIRMAN ARMSTRONG: Seeing that let's move on. Caitlin, can you talk about the Shad Habitat Plan Timeline? UPDATE

MS. STARKS: Yes. This update is about those American shad habitat plans, which I'll just remind you are required under Amendment 3. All states and jurisdictions must submit a habitat plan for American shad, and we discussed this at the last meeting in February, and the Board asked the states to update those habitat plans, since it's been about five years since they were originally submitted.

With the exception of the Merrimack and Hudson Rivers, these were just the updates to the information that has already been put together, but the Merrimack and Hudson Rivers do not have management plans currently. The states did begin the process of reviewing those plans earlier this year.

However, as you can imagine with everything going on in the world right now, and COVID-19, many of the TC members have indicated to me that they have encountered delays, and it's unlikely that any states will be able to complete updates of their plans in time for the October, 2020 meeting.

Considering that, my recommendation is that the states should aim to update their plans and submit new plans for the Hudson and Merrimack in time for consideration at the winter 2021 ASMFC meeting. If the Board is okay with that plan, we would expect the states to submit plans to the TC for review in December at the latest, so that the Board could then consider them in February. That is all I have on that issue.

CHAIRMAN ARMSTRONG: All right. We could do a motion on this to allow extra time, I don't think we need to. I think just a head nod would be okay, given the circumstances. Does anyone have any heartburn with extending the timeline a little bit for the completion of the habitat plans?

MS. KERNS: We have Bill Hyatt with his hand up.

CHAIRMAN ARMSTRONG: Go ahead, Bill.

MR. HYATT: No heartburn, this is just a real quick question. I was just wondering if these habitat plans include passage, dam removals, those types of items, if that is part of what is included.

MS. STARKS: Yes. I can send around an outline, but the information is in Amendment 3, and it does include things like restoration efforts, dam removals, passage, additions, and things like that. We would want to get updates from the states on additional projects that have gone on during the last five years since these were implemented, state plans were implemented.

MR. HYATT: Very good, thank you.

CHAIRMAN ARMSTRONG: Okay, any other comments?

MS. KERNS: I do not see any other hands raised, Mike, and I agree we don't need a motion to delay.

CHAIRMAN ARMSTRONG: All right, we will consider that a group nod, and we'll see those plans in January, I guess.

ELECT VICE-CHAIR

CHAIRMAN ARMSTRONG: All right, we have one remaining item, well two with Other Business. We need to elect a Vice-Chair, a critical action. Would anyone like to make a motion to nominate someone?

MS. KERNS: We have Ray Kane.
CHAIRMAN ARMSTRONG: Ray Kane, go ahead, please.

MR. RAYMOND W. KANE: I would like to nominate Dr. Justin Davis from the state of Connecticut as Vice-Chair.

CHAIRMAN ARMSTRONG: Thank you for that motion, do we have a seconder?

MS. KERNS: Dennis Abbott.

CHAIRMAN ARMSTRONG: Thank you, Dennis, seconded by Dennis Abbott. Is there any discussion?

MS. KERNS: No hands.

CHAIRMAN ARMSTRONG: Seeing none, the motion carries by consensus. Congratulations, Justin. Which brings us to Other Business. Does anyone have any other business?

MS. KERNS: I do not see any hands.

ADJOURNMENT

CHAIRMAN ARMSTRONG: Again, I really want to thank the Stock Assessment Committee and the Review Committee. That was an awesome job, and you've got a lot to do. The stocks still remain in pretty tough shape, so with that we'll look for the future and this meeting is adjourned.

(Whereupon the meeting ended at 12:23 p.m. on August 4, 2020)

Atlantic States Marine Fisheries Commission

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MEMORANDUM

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

FROM: **Shad and River Herring Technical Committee**

DATE: **January 15, 2021**

SUBJECT: **TC Recommendations on improving shad stocks given assessment results**

In August 2020, the Board reviewed and accepted the 2020 Benchmark Stock Assessment for American shad (assessment), which found that the coastwide metapopulation is depleted, and adult mortality for several system-specific stocks is unsustainable. Additionally, the assessment concluded that shad rebuilding is limited by restricted access to spawning habitat. In response, the Board tasked the Shad and River Herring Technical Committee (TC) to "*identify potential paths forward to improve shad stocks along the coast considering the assessment results*." The TC met several times via webinar following the August 2020 meeting to address this task.

The TC considered potential management and monitoring improvements for specific stocks identified in the assessment as unsustainable, depleted, or of unknown status with an active fishery. In addition, the TC developed broad recommendations for the coastwide metapopulation. A summary of the TC's system-specific and coastwide recommendations are summarized below. For each system, more information and rationale for the TC recommendation is provided in individual memos (enclosed).

Connecticut River

The assessment found that adult mortality for the Connecticut River stock is unsustainable. However, the annual adult shad fish lift counts have shown an increasing trend over the past 12-15 years, even as total mortality has remained very high. In addition, the sustainability metrics in the approved Sustainable Fishery Management Plan (SFMP) have remained above target levels, with the exception of the initial year of the plan's implementation. The TC agrees that high downstream mortality at hydropower facilities and other associated factors are the primary sources of Connecticut River shad mortality, rather than fishery effort, and that the current low levels of fishing activity have not contributed to the increased values of total mortality in the system. Therefore, the TC does not recommend any further restrictions to the Connecticut River shad commercial and recreational fisheries. The TC recommends the following actions as pathways to improve the stock:

- Continue to closely monitor the metrics currently used to gauge fishery sustainability: adult lift passage, juvenile abundance, and adult escapement and implement management response to negative metrics, as appropriate
- Work with Connecticut River Atlantic Salmon Commission partners to realize continued passage and habitat improvements
- Explore alternative (non-creel) survey methods to provide recreational effort and harvest estimates

Delaware River

The assessment found that adult mortality for the Delaware River stock is unsustainable. The TC does not recommend any changes to management or monitoring for the 2021 fishing season. The TC recommends the following actions as first steps for addressing the Delaware River stock:

- Revise the SFMP to include updated data and stock assessment results, and incorporate a management response to be triggered by an unsustainable adult mortality determination from the stock assessment. Potential management responses that will be considered by the Delaware River Basin Fish and Wildlife Management Cooperative include:
    - Closure of commercial fishery; recreational catch and release only
    - Reduce commercial fishery by 50% through gear restrictions, seasons, trip limits, or quota reduction; reduce recreational fishery to 1 fish bag limit
    - Reduce commercial fishery by 25% through gear restrictions, seasons, trip limits, or quota reduction; reduce recreational fishery to 2 fish bag limit
    - Gill nets with stretch mesh greater than or equal to 4 inches and less than 7 inches will be prohibited below the mixed stock demarcation line during February 1st - May 31st. Harvest of American shad as bycatch (American shad <50% of harvest by weight) is still permissible below the demarcation line from Bowers Beach, DE to Gandys Beach, NJ.

Potomac River

The assessment found that adult mortality for the Potomac River stock is unsustainable. Additional years of data not included in the assessment (2018-2020) show continued increasing trends in the Potomac Pound Net Catch per Unit Effort index, as well as increasing trends for shad in the Potomac River Striped Bass Spawning Stock and Juvenile Seine Surveys. The current known sources of in-river removals include broodstock collection programs, and limited bycatch harvest by in-river pound and gill net fisheries. The TC was concerned that further restricting these minor removals could result in reduced data availability for assessment, and would likely not have a significant positive impact on the stock. The TC recommends the following actions as pathways to improve the stock:

- Reduce or eliminate harvest/bycatch of Potomac River origin American shad in ocean fisheries (near term, high priority)
- Prioritize conservation of natural land cover throughout the lower Potomac watershed (ongoing, long term, high priority).
- Continuation of expansion of commercial and recreational fisheries on non-native predators (blue catfish and flathead catfish) in the Potomac River (ongoing, high priority).
- Identify the contribution of Potomac River origin American shad to mixed stock ocean bycatch through the collection and submission of biological samples (i.e. American shad fin clips) to the U.S. Geological Survey for their effort in building a comprehensive genetic tissue repository for alosine species (Starting in 2021, high priority).

Hudson River

The assessment found that the Hudson River stock is depleted. There is currently no harvest of American shad permitted in the system. TC agrees that harvest of Hudson-origin shad in mixed-stock fisheries in large coastal bays (i.e. Delaware Bay), incidental bycatch of American shad in federal fisheries, and habitat loss are the main factors affecting the status of the stock. The TC recommends the following actions as potential pathways to improve the stock:

- Reduce/eliminate harvest of Hudson shad in mixed-stock fisheries and ocean bycatch (near-term; high priority)

- Identify stock composition of bycatch occurring in Federal fisheries and quantify impact to the Hudson stock (near-term; high priority)
- Implement habitat restoration actions identified in the Hudson River Estuary Habitat Restoration Plan (Miller 2013) to restore high-quality spawning, nursery and refuge habitats for American shad (on-going, long-term; high priority)
- Continuation of fishery closure until recovery targets (Hudson River American Shad Recovery Plan, in prep) are met and stocks are robust enough to support sustainable harvest (long-term; high priority)

Maine Systems

The assessment determined that American shad stock status throughout Maine is unknown. The two major areas of concern addressed in the assessment regarding data were insufficient time series length and validity of count data collected at monitored fishways on Maine's larger rivers. The TC agreed that there is currently limited potential to improve biological data collection due to small run sizes, so the TC recommends the following action as a pathway to improve Maine shad stocks:

- Removal of significant barriers to upstream passage. This may enhance production, increase abundance and provide more opportunity to collect biological data through additional sampling methods without taking a significant portion of the returns to a system.

Merrimack River

The assessment determined that the American shad stock status in the Merrimack River is unknown; data were insufficient to determine abundance status, and deficiencies with low age samples in some years prevented the calculation of a mortality estimate. The Merrimack SFMP benchmark for spawning run sustainability has been achieved with an increasing trend in the last 10 years. However, the SFMP's warning threshold on shad mortality (based on Amendment 3 provides benchmark values for New England) has been exceeded each year since 2013. Based on the assessment findings and this additional data, the TC recommends the following focal areas and actions as pathways to improve the stock:

- Merrimack River Shad Mortality: Commit to addressing concerns with data time series and age sample sizes as indicated in SFMP. Discuss goals, and focus new staff on sampling targets and the need to improve the data quality and utility of mortality estimates for some years.
- Juvenile Abundance Index: No historical or recent efforts have been undertaken to create a shad juvenile abundance index (JAI) on the Merrimack River, though state and federal agencies have discussed an interest in developing a JAI index. Concerns have been expressed over inherent high variability in shad JAI indices on the East Coast, and most importantly, no identified funding source to support a JAI index project.
- Repeat Spawning Ratio: Improve spawning ratio data time series through ongoing shad scale aging. The current time series is too brief to use the data for setting a repeat spawning ratio benchmark or to discern any trends.
- Restoration Efforts: Poor passage at mainstem dams and tributaries without passage is a significant limitation to increasing shad populations. Continue annual reviews with hydropower dam owners to identify operation and maintenance issues that can impact shad passage and recommended improvements. Continue development of a Comprehensive Plan for fish restoration in the Merrimack system that will set target population levels and prioritize restoration efforts during the Pawcatuck Dam relicensing process.

Tar-Pamlico

The assessment determined that the American shad stock status in the Tar-Pamlico system is unknown, due to insufficient data. SFMP sustainability metrics, including relative female abundance and relative fishing mortality (F) for female shad derived from the electrofishing survey, have not triggered a management response; however, the female abundance index has fallen below the threshold in the last two years for which data is available (2018 and 2019, data are unavailable for 2020 due to COVID-19 pandemic restrictions). The estimate of female relative F has remained well below the threshold since 2013, consistent with a decline in commercial landings. In 2017, NCDMF initiated exploratory juvenile abundance sampling for striped bass using trawl and seine nets in the Tar-Pamlico and Neuse rivers. While the focus of the survey is to obtain juvenile striped bass, the survey may also intercept American shad and may be of use for a juvenile abundance index in the future.

Additionally, a management response for striped bass has been in effect since March 18, 2019 prohibiting the use of all gill nets upstream of the ferry lines from the Bayview to Aurora Ferry in the Tar-Pamlico River and the Minnesott Beach and Cherry Branch ferry in the Neuse River. While targeting striped bass, this action also protects American shad by removing gill nets from the normal fishing grounds for American shad in the Tar-Pamlico River.

- Considering the recent management and monitoring changes described above, the TC recommended no additional actions for the Tar-Pamlico system at this time.

Cape Fear

The assessment determined that the American shad stock status in the Cape Fear system is unknown, due to insufficient data. The 2020 Benchmark Stock Assessment noted that there is an increasing trend in adult abundance, likely a sign of improved passage at Lock and Dam 1. Monitoring under the current SFMP is sufficient to detect any changes in abundance. Annual updates to sustainability parameters for female relative abundance and female relative F have not exceeded their thresholds since 2011 and 2012, respectively. Additionally, in 2017, NCDMF initiated exploratory juvenile abundance sampling for striped bass using trawl and seine nets in the Cape Fear River and its tributaries. While the focus of the survey is to obtain juvenile striped bass, the survey may also intercept American shad and may be of use for a juvenile abundance index in the future.

- Considering the assessment findings and the information above, the TC does not recommend any changes to management or monitoring requirements for the Cape Fear system at this time.

South Carolina Systems

The assessment determined that the American shad stock status for the Winyah Bay, Santee-Cooper, and Ace Basin systems are unknown due to insufficient data. Commercial fisheries occur in these systems under approved SFMPs. Additional information considered by the TC for each system is summarized below.

Winyah Bay: Young of Year (YOY) abundance data were not available, and there have been conflicting trends in adult abundance since 2005, further confounding assessment of abundance conditions in recent years. Data from fishery independent gill netting on the Waccamaw River (currently 2011-2020) will meet the minimum time series requirement and will be available for the next benchmark stock assessment. Electrofishing sampling for YOY juvenile shad began in 2011 and has occurred every year since. These data (currently 2011-2020) will meet the minimum time series (ten years) and will be available for the next benchmark stock assessment.

Santee-Cooper: YOY abundance data were not available and there have been conflicting trends in adult abundance since 2005, with an increasing trend detected from the Cooper River Recreational Creel Survey and no trend detected from the Santee River Adult Gill Net Survey or Santee River Commercial CPUE. Data from fishery independent gill netting on the Santee River (currently 2011-2020) will meet the minimum time series requirement and will be available for the next benchmark stock assessment. Electrofishing sampling for YOY juvenile shad began in 2011 and has occurred every year since. These data (currently 2011-2020) will meet the minimum time series and will be available for the next benchmark stock assessment.

ACE Basin: There were no YOY abundance data available and no trend detected in adult abundance since 2005. Electrofishing sampling for YOY juvenile shad began in 2011 and has occurred every year since; these data (currently 2011-2020) will meet the minimum time series and will be available for the next benchmark stock assessment.

- Considering the assessment findings and the information above, the TC does not recommend any changes to management or monitoring requirements for South Carolina systems at this time.
- The TC agrees with recommendations proposed by South Carolina to continue and improve existing monitoring programs and sampling efforts in all systems to expand the time series to meet the assessment threshold of ten years. Specific monitoring recommendations are included in the enclosed memo from South Carolina. The highest priority is beginning to collect age samples from otoliths in addition to scales.

Savannah River

The assessment determined that the American shad stock status in the Savannah River is unknown. Currently, commercial fisheries are pursued by both SC and GA under approved SFMPs. There were no YOY abundance data sets with appropriate time series available and no trend detected in adult abundance (two data sets) since 2005. As part of an ongoing sampling program, GADNR conducts electrofishing for spawning adult shad; these data (currently 2010-2020) will meet the minimum time series (ten years) and will be available for the next benchmark stock assessment. Additionally, SCDNR has conducted electrofishing sampling for YOY juvenile since 2011; these data will meet the minimum time series and will be available for the next benchmark stock assessment.

- Considering the assessment findings and the information above, the TC does not recommend any changes to management or monitoring requirements for the Savannah River at this time.
- South Carolina and Georgia intend to continue and improve existing monitoring programs and sampling efforts in all systems to expand the time series to meet the assessment threshold of ten years. Specific monitoring recommendations are included in the enclosed memos from South Carolina and Georgia.

Altamaha River

The assessment determined that the American shad stock status in the Altamaha River is unknown. A commercial fishery occurs in this system under an approved SFMP. There were no YOY abundance data sets with appropriate time series available, and abundance indices showed conflicting trends. Since 2010, GADNR has conducted seine surveys to collect data on YOY shad; these data will meet the minimum time series and will be available for the next benchmark stock assessment. Additionally, GADNR will consider implementing improvements to the Altamaha River Tagging Survey that were recommended in the assessment.

- Considering the assessment findings and the information above, the TC does not recommend any changes to management or monitoring requirements for the Altamaha River at this time.
- Georgia intends to evaluate and discuss possible changes to improve management and monitoring. In particular, the state is considering collecting both otoliths and scales for age data.

St. Johns River

The assessment determined that the American shad stock status in the St. Johns River is unknown. Trend analysis of YOY and spawning stock abundance indices showed no trend and an increasing trend, respectively. It is likely that the population was stable or improving during the assessment period, since neither index declined over time and mean fork length of males and females both increased. Additional data that could aid in stock status determination are being collected; spawner otoliths are available for age composition and size-at-age starting in 2011, and a time series greater than ten years will be available for the next assessment. Currently, the only known source of American shad removals is recreational harvest permitted under the approved SFMP.

- Considering the assessment findings and the information provided by the state, the TC does not recommend any changes to management or monitoring requirements for the St. Johns River at this time.
- The TC recommends that FL improve monitoring data by better accounting for environmental variability effects, and using age data to identify year class and maturity schedule.

Coastwide Recommendations

The TC also discussed pathways for improving shad stocks at the coastwide level. In general, the TC felt that management restrictions at the system level are not likely to produce the desired result, given that directed harvest is already significantly restricted and current habitat conditions and other factors such as passage are limiting population recovery at a larger scale. Therefore, the TC recommends the following actions to improve data quality and availability for assessment, and to lay a stronger foundation for success in shad recovery efforts along the coast.

- The TC agrees that upstream and downstream passage mortality pose substantial threats to shad stocks along the coast and limit the potential for population recovery. The assessment provided analysis suggesting that passage barriers reduce coastwide spawner production potential by as much as 41%. To address this issue, the TC recommends that further action by the Board or Commission is needed to promote or implement measures to improve fish passage along the coast. The TC is currently developing a memo to provide the Board with more detail and recommendations on this issue.
- The TC does not recommend any changes to the current monitoring requirements established in Amendment 3. However, the TC recommends that states aim to improve their surveys to increase survey power to meet the assessment threshold of 80% power to detect a change of 50% over a 10 year time period, when feasible.
- The TC recommends paired otoliths and scales be collected in all systems where it is possible.
- The TC recommends the Board task them with developing alternative methods or metrics to evaluate bycatch removals in directed mixed-stock fisheries in state waters. Such methods are needed to understand and reduce impacts to stocks outside the area where directed catch occurs.
- The TC recommends that system-specific restoration targets should be developed for those systems where appropriate and when sufficient data are available, or revisited where they already exist. These targets should be incorporated in shad habitat plans and existing SFMPs during the next update. The TC would provide input on restoration targets proposed for

inclusion in the SFMPs. The rationale is that this will provide measurable goals for evaluating recovery efforts.

Of the high priority research recommendations identified in the assessment, the TC wanted to highlight two in particular that would contribute the most to the ability to improve shad stocks and the assessment:

- Conduct annual stock composition sampling through existing and new observer programs from all mixed-stock fisheries (bycatch and directed). Potential methods include tagging (conventional external tags or acoustic tags) of discarded catch and genetic sampling of retained and discarded catch. Mortality rates of juvenile fish in all systems remain unknown and improvement in advice from future stock assessments is not possible without this monitoring. Known fisheries include the Delaware Bay mixed-stock fishery and all fisheries operating in the Atlantic Ocean (U.S. and Canada) that encounter American shad (see Section 4.1.4 in the stock assessment report).
- Otoliths should be collected as the preferred age structure. If collection of otoliths presents perceived impact to conservation of the stock, an annual subsample of paired otolith and scales (at least 100 samples if possible) should be collected to quantify error between structures.
    - The TC recognizes that otoliths are difficult to obtain from some sources (e.g., for fishery dependent sampling it will be difficult to obtain the otolith and/or the recommended subsample of 100 paired otoliths/scales per system without purchase or donation of fish from harvesters). Therefore, the TC agrees that scales can continue to be collected from data sources where otoliths are unable to be collected.

Connecticut Department of
ENERGY &
ENVIRONMENTAL
PROTECTION

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Memo

To: Caitlin Starks, SRH FMP Coordinator; ASMFC Shad and River Herring Technical Committee

From: Jacque Benway, CT DEEP Fisheries Division, Marine Fisheries Program

Date: 12/8/2020

Re: Summary of CT DEEP CT River shad monitoring and management recommendations in response to stock status designation from the 2020 American Shad Coastwide Stock Assessment.

The Shad and River Herring Technical Committee has requested that all states provide context that may explain the 2020 American Shad Stock Assessment findings. This response from the State of Connecticut/ Commonwealth of Massachusetts addresses concerns over the status of American Shad (*Alosa sapidissima*) in the Connecticut River. Please note that Massachusetts has reviewed the draft memo and consulted with Connecticut on this inquiry. Both states agree on the current status and necessary actions for the Connecticut River American Shad population.

- ***Identify areas of concern identified in the assessment (e.g. stock status, data deficiencies preventing stock status determination, habitat issues)***

The recent results from the 2020 shad stock assessment were based on the following CT River data: CT River Commercial Adult shad catch and effort, 1995-2017 (no trends detected), Long Island Sound Trawl Survey relative abundance (primarily subadults, potentially mixed stocks), CT River Juvenile shad seine survey data below the Holyoke Dam, 1978-2017 (no apparent trend with peak value in 2016), Adult Shad scale age structure from Commercial catches (no trend) and Holyoke fish lift (Mann-Kendall Trend analysis detected a decrease in mean length-at age in age 6 for females and males), and annual Adult shad Holyoke fish lift counts (increasing trend after 2005).

The primary concern of the Stock Assessment Sub-Committee (SAS) was that the CT River had high total mortality estimates. In the stock assessment, the Regional Metapopulation Northern Iteroparous total mortality threshold at Z40% was set at 1.00. Average adult mortality during the last 3 years of the assessment time series (2015-2017: Z = 1.40, SE = 0.59) was greater than respective regional per-recruit reference point for the CT River shad stock.

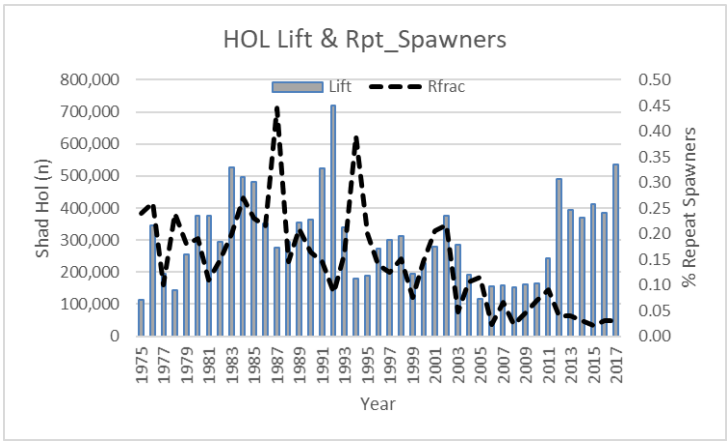
- ***Identify additional information not considered in the assessment stock status determination that provides more context on the stock, fishery, etc. (e.g. more recent years of data, SFMP metrics and performance, survey trends)***

As noted by the SAS, the annual Adult shad fish lift counts have shown an increasing trend over the past 12 – 15 years even as total mortality has remained very high. Over this time period, the Connecticut River Atlantic Salmon Commission (CRASC), which cooperatively manages diadromous fish in the CT River Basin, has identified downstream adult and juvenile mortality as an issue for the CT River shad population and has

been working to understand these issues through modeling approaches (*see* Addendum on American Shad Passage Performance Criteria, for the Connecticut River American Shad Plan, CRASC 2020) as well as working with the operators of the Holyoke Dam to improve downstream passage conditions. The most recent changes were made in 2016, at the end of the time series used in the assessment. CT DEEP and MA DMF believe that high downstream mortality at hydropower facilities and other associated factors are the primary sources of CT River shad mortality, rather than fishery effort. Details on repeat spawner rates, commercial fishing effort, recreational fishing effort, and the current approved SFMP that support this argument are provided below, followed by the information we have identified to improve mortality estimates and partitioning.

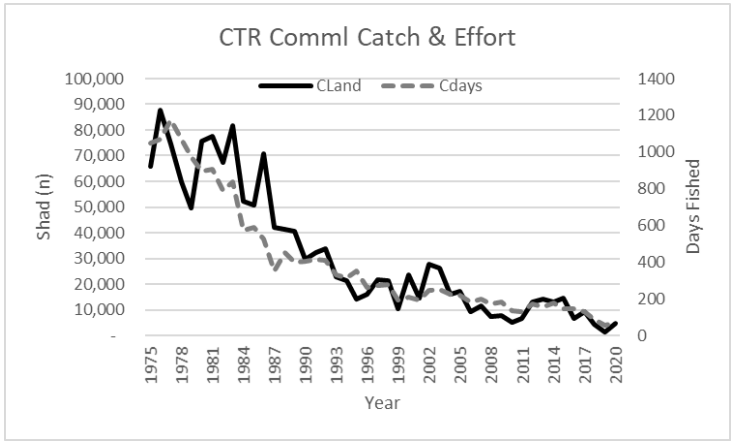
Repeat Spawner rate time series:

The average fraction of repeat spawners (age aggregated and sexes combined) has been monitored annually for Connecticut River shad since 1966. Repeat spawning is based on the presence of one or more spawning scars on scale samples. The fraction of repeat spawners in the population is a measure of inter-annual survival, and an instantaneous total mortality rate was calculated annually. The calculated annual Z estimates have increased steadily from 1966-2017 from a low of 0.8 in the mid 1960s to over 3.5 in 2008. Except for 1987 and 1994, the estimated instantaneous Z values calculated based on the rate of repeat spawners have always exceeded the Z40% threshold of 1.00.

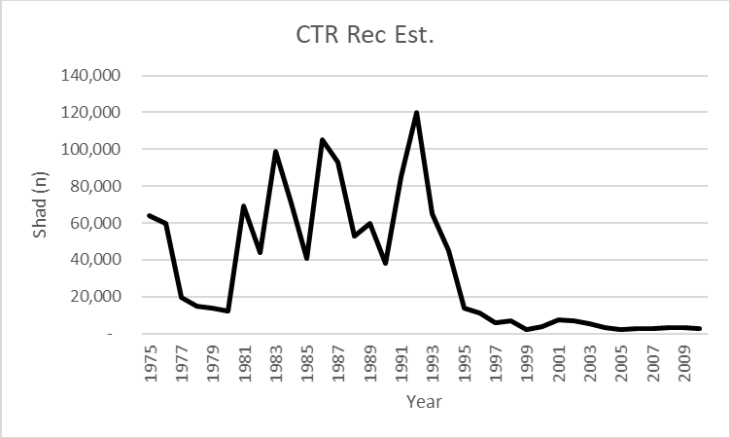


CT River Commercial Landings

The number of commercial shad fishing licenses and associated effort has been steadily declining since peak levels during and after World War II. Recent commercial license sales have declined to low levels, less than 10 license holders annually, and are expected to stay low or further decrease as fishermen retire and are not replaced. A high proportion of license holders exceed age 58 as few new participants have entered the fishery in the last decade. The commercial shad fishery is managed through area, gear, and season restriction as well as rest days. The American shad gill net season runs from April 1 through June 15. The annual landings for the CT River Commercial Fishery have continued to decline since the terminal year of data submitted for the stock assessment. Landings in 2019 were at an all-time low for the time series.



CT River Recreational Fishery: The CT River recreational fishery takes place in Connecticut from Hartford to the state line during the upstream migration of shad. The recreational catch and effort data was not included in the assessment, since the time series has not been continuous in recent years. The CT recreational fishery for Shad was monitored in CT portions of the river (Hartford to state line) from 1980-1996 and periodically (generally every 5 years) from 1996 to 2010. Recreational shad landings in CT began to fall dramatically after 1995 to a point where harvest estimates from creel surveys were unreliable and imprecise as reflected by high (> 80%) proportional standard errors about the mean harvest estimates. Because of the low precision around catch estimates due to a low incidence of positive intercepts in the creel survey, recreational creel surveys decreased to five year intervals (i.e. 2000, 2005 and 2010). After 2010, there have not been enough staffing or funding resources at CT DEEP to conduct a creel survey.

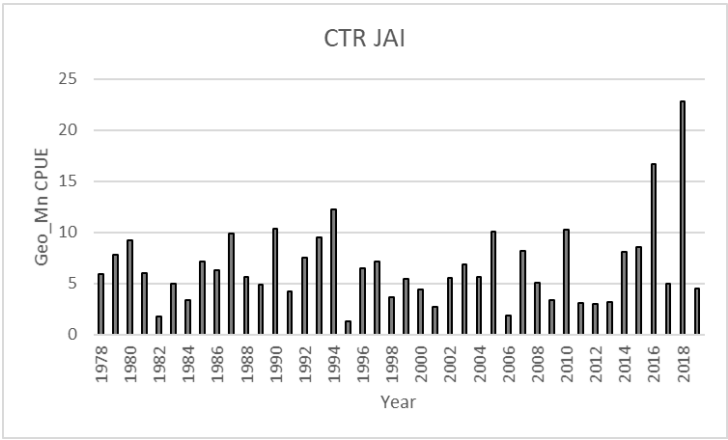


Access to traditional shad fishing sites along the Connecticut River has changed over the years with infrastructure changes, restricted shore access due to development and the natural breaching of a low head dam in Enfield.

CT Sustainable Fishing Management Plan:

Approved in 2013 and renewed in 2017, CT uses 3 metrics to monitor sustainability of CT Fisheries. The first response metric is passage, or the number of adult fish lifted at the first main stem dam in Holyoke MA. The trigger for passage is 140,000 fish. Recruitment (JAI) at this value has varied independent of adult stock size, indicating sufficient stock reproductive capacity to support future stock reproduction and recruitment. The second metric is Recruitment Failure (recruitment), defined in Amendment 3 as three consecutive years of recruitment in the lower quartile of the time series.

The third metric, escapement, is a measure of fishing pressure on the stock expressed as the proportion of the total run "escaping" the fishery to spawn. A conservative trigger of 90% escapement was chosen to facilitate timely review of potential implications for future stock.



The sustainability metrics have remained above target levels, with the exception of the initial year of the plan's implementation. In 2013, the JAI fell below the threshold. Since then, all targets have remained above the thresholds to date.

Information needed to determine additional contributors to mortality other than F:

- Holyoke lift annual mortality estimates for upstream and downstream passage for adults & juveniles
- Current assessment of the annual proportion of the shad stock that passes upstream at the Holyoke fish lift
- Recent predation impacts (e.g. striped bass) on CT River shad (adults & juveniles)
- Continuation of support of habitat restoration (e.g. through the FERC relicensing process)
- New methods to estimate recreational effort
- Continued research that would give better insight into stock composition of mixed-stock fisheries and stock composition of oceanic bycatch.

- ***Suggest management or monitoring changes, or restoration efforts that would improve shad stock based on the information above***

As noted above, the non-fishing mortality component of shad stock Z estimates is a high proportion of the total mortality, while fishing mortality has remained a small proportion in recent decades. This has been a challenge for management of the CT River shad stock. More research is needed in the CT River Basin to quantify the additional contributors to mortality. Despite the persistent declines in both the commercial and recreational harvest over the last several decades, there has not been any appreciable benefit to stock levels or mortality estimates. To that effect, recent JAI levels have been among the highest values of the time series while adult harvest has been at the lowest levels but total mortality has been above the threshold. We believe that any further fishery reductions would not have any positive effects on recruitment or the stock status, and any fishing mortality reductions would likely be offset or compensated for by other sources of mortality, resulting in no significant decrease of total mortality.

At this time, we recommend no further restrictions to the CT River shad commercial and recreational fisheries. We believe that the current low levels of fishing activity have not contributed to the increased values of total mortality in the CT River system. CT DEEP and MA DMF will continue to closely monitor the metrics currently used to gauge fishery sustainability: adult lift passage, juvenile abundance, and adult escapement. If one or more metrics are triggered, management response will include closer examination of actual metric values and other relevant biological and environmental factors contributing to the perceived stock condition. Fishery management action is contingent on a finding that harvest rates are materially contributing to diminished adult stock or recruitment. Management actions in response to 3 negative metrics could include, but may not be limited to one or more of the following: decrease in length of season, increase in number of rest days, decrease in recreational bag limit. Additionally, CT DEEP and MA DMF will work with CRASC partners to realize continued passage and habitat improvements and intend to explore alternative (non-creel) survey methods to provide estimates of recreational fishery effort and harvest.

Delaware River Basin Fish and Wildlife Management Cooperative

Cooperators
Delaware Division of Fish and Wildlife
National Marine Fisheries Service
New Jersey Division of Fish & Wildlife
New York Division of Marine Resources
Pennsylvania Fish & Boat Commission
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717-387-2117

Caitlin Starks
Atlantic States Marine Fisheries Commission
1050 N. Highland St. #200A
Arlington, VA 22201

5 November 2020

Dear Ms. Starks:

The Delaware River Basin Fish and Wildlife Management Cooperative (The Co-op) met on October 8th to discuss the three questions directed to States with an unsustainable, depleted, or unknown stock determinations from the ASMFC Shad and River Herring Technical Committee (email dated 10/2/20). The consensus of the group is presented below.

- *Identify areas of concern identified in the assessment (e.g. stock status, data deficiencies preventing stock status determination, habitat issues)*
  The Co-op thought the assessment was extremely thorough and accurately reflected the status of the stock.

- *Identify additional information not considered in the assessment stock status determination that provides more context on the stock, fishery, etc. (e.g. more recent years of data, SFMP metrics and performance, survey trends)*
  The Co-op thought that all available and appropriate information was considered in the stock status determination.

- *Suggest management or monitoring changes, or restoration efforts that would improve shad stock based on the information above*
  The current Sustainable Fisheries Management Plan (SFMP) outlines steps that Delaware Basin States could take in response to hitting management triggers outlined in that plan. While an unsustainable stock determination does not technically trigger management action as defined in the SFMP, we consider these actions as potential options to respond to the unsustainable determination from the stock assessment. These options are listed below. The Co-op will continue to discuss these, and other options, through the development of the update to the SFMP due in 2021. This update will include both more recent data (2018 and 2019) and significant ongoing habitat assessment work being conducted by The Nature Conservancy.

- Closure of commercial fishery; recreational catch and release only
- Reduce commercial fishery by 50% through gear restrictions, seasons, trip limits, or quota reduction; reduce recreational fishery to 1 fish bag limit
- Reduce commercial fishery by 25% through gear restrictions, seasons, trip limits, or quota reduction; reduce recreational fishery to 2 fish bag limit
- Gill nets with stretch mesh greater than or equal to 4 inches and less than 7 inches will be prohibited below the mixed stock demarcation line during February 1st through May 31st. Harvest of American Shad as bycatch (American Shad < 50% of harvest by weight) is still permissible below the demarcation line from Bowers Beach, DE to Gandys Beach, NJ

Response to address assessment results of unsustainable adult American Shad mortality in the Potomac River

Ellen B. Cosby, Potomac River Fisheries Commission

Robert J. Bourdon, MD Dept. of Natural Resources

Areas of Concern

During the 2020 benchmark stock assessment, the mortality status of the Potomac River American shad stock was assessed using both catch curve and statistical catch at age (SCAA) models. The catch curve analysis was the preferred method for determination of mortality relative to the $Z_{40\%\ SBPR}$ reference point identified for the southern iteroparous metapopulation. The terminal three-year (2015-2017) average adult instantaneous total mortality exceeded the reference point, signaling that the Potomac American shad stock was experiencing unsustainable mortality levels. While not chosen as the favored assessment method due to retrospective bias, the results of the SCAA model corroborated the results of the catch curve analysis.

Additional Data for Consideration

PRFC	Commercial Bycatch Harvest		PN Discards/ Releases	PN CPUE (C + D)	PN GM Index	YOY GM Index
	Pound net	Gill net				
2018	18,146	374	19,300	145.14	47.3	7.36
2019	17,546	341	8,050	99.68	49.0	10.86
2020	12,310	4,693	16,750	148.27	51.5	8.68

MD DNR	PRFC Collection Permit	# A. Shad collected	Restoration stocking
2018	Yes	1,444	352,000 fry
2019	Yes	1,168	Unknown – no report
2020	No	0	0

USFWS	PRFC Collection Permit	# A. Shad collected	Restoration stocking
2018	Yes	2,397	470,083 viable eggs
2019	Yes	40 (1 day)	53,582 viable eggs
2020	Yes	0	0

DOEE	PRFC Collection Permit	# A. Shad collected	Restoration stocking
2018	**Yes**	**179**	**50,000 viable eggs**
2019	**Yes**	**Unknown**	**Unknown – no report**
2020	**No**	**0**	**0**

VDGIF	PRFC Collection Permit	# A. Shad collected	Restoration stocking
2018	**No**	**0**	**0**
2019	**No**	**0**	**0**
2020	**No**	**0**	**0**

AWS	PRFC Collection Permit	# A. Shad collected	Restoration stocking
2018	**Yes**	**49**	**17,683 fry**
2019	**Yes**	**69**	**9,500 fry**
2020	**Yes**	**Unknown**	**Unknown**

MD DNR Potomac River Striped Bass Spawning Stock Survey

Updated data for the MD DNR Potomac River Striped Bass Spawning Stock Survey provided an additional two years of data (2018 and 2019) compared to what was considered for the benchmark stock assessment (1985-2017). Geometric mean catch-per-unit-effort (GM CPUE), represented as the number of fish/1000 yds^2/hour, was the highest on record in 2019. Mann-Kendall trend analyses detected an increase in GM CPUE over the entire time series ($z = 6.11$, $n = 34$, $p < 0.001$). Additionally, an increase in GM CPUE was detected during the reference period of 2005-2019 ($z = 2.43$, $n = 15$, $p = 0.01$); this represents a departure from the results of the stock assessment which found no trend in GM CPUE for 2005-2017.

Updated catch-at-age matrices by sex are available from this survey should the commission wish to calculate total adult mortality for the three terminal years of 2017-2019.

MD DNR Potomac River Striped Bass Juvenile Seine Survey

Updated data for the MD DNR Potomac River Striped Bass Juvenile Seine Survey provided an additional two years of data (2018 and 2019) compared to what was considered for the benchmark stock assessment (1959-2017). Geometric mean catch-per-unit-effort (GM CPUE), represented as catch per seine haul, reached its second highest value on record in 2019. Mann-Kendall trend analyses detected an increase in GM CPUE over the entire time series ($z = 5.05$, $n = 61$, $p < 0.001$). Additionally, an increase in GM CPUE was detected during the reference period of 2005-2019 ($z = 1.98$, $n = 15$, $p = 0.048$); this represents a departure from the results of the stock assessment which found no trend in GM CPUE for 2005-2017.

Management and Monitoring Considerations

The primary sources of anthropogenic mortality impacting Potomac American shad are broodstock collection programs, limited bycatch harvest by in-river pound and gill net fisheries, and bycatch in ocean fisheries. It has been hypothesized that stocks with higher abundances, such as the Potomac River, may be disproportionately impacted by ocean fisheries. Unfortunately, sufficient genetic information to support this claim is not currently available and Potomac origin bycatch is unable to be quantified. However, the Maryland Department of Natural Resources will begin providing genetic samples for alosine species from a number of Maryland rivers in 2021 as part of a US Geological Survey effort to build a comprehensive tissue repository for alosine species. Genetic information generated by this project will be useful for stock identification of American shad bycatch. The collection of Potomac American shad tissue samples will be given high priority by this project in 2021.

Sources of mortality of early life phases of American shad in the Potomac are not well understood and cannot be quantified. However, the MD DNR Fisheries Habitat and Ecosystem Program (FHEP) has demonstrated that the presence of alosine eggs and larvae is negatively correlated with the amount of impervious surfaces in a watershed (Uphoff et al., 2017). Increased coverage of impervious surfaces due to urban and suburban development in watersheds increases runoff volume and intensity into streams, thus increasing the exposure of aquatic organisms to sedimentation, thermal pollution, contaminant loads, road salts, and nutrients. Given the high level of urbanization in the upper regions of Potomac American shad habitat, spawning success may be inhibited by poor water quality. The land areas surrounding the upper reaches of American spawning and rearing habitat have been identified as a watersheds to re-engineer by the FHEP (Uphoff et al., 2017). The land areas surrounding the middle and lower portions of American shad spawning and rearing habitat are primarily forested and have been identified as conservation watersheds (Uphoff et al., 2017). Despite the intensity of development in some portions of the Potomac watershed, relative abundance of juvenile American shad, as estimated by the MD DNR Potomac River Striped Bass Juvenile Seine Survey, has increased over time (1959-2019). The two most abundant year classes detected as YOY by the survey were 2015 and 2019.

Suggested management, monitoring actions and restoration efforts:

1) Identify the contribution of Potomac River origin American shad to mixed stock ocean bycatch (near term, high priority).
2) Reduce or eliminate harvest/bycatch of Potomac River origin American shad in ocean fisheries (near term, high priority)
3) Prioritize conservation of natural land cover throughout the lower Potomac watershed (ongoing, long term, high priority).

4) Continuation of expansion of commercial and recreational fisheries on non-native predators (Blue catfish and Flathead catfish) in the Potomac River (ongoing, high priority).
5) Collection and submission of biological samples (i.e. American shad fin clips) to the U.S. Geological Survey for their effort in building a comprehensive genetic tissue repository for alosine species (Starting in 2021, high priority).

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NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

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30 October 2020

Caitlin Starks
Shad and River Herring FMP Coordinator
Atlantic States Marine Fisheries Commission
1050 N Highland St #200
Arlington, VA 22201

Dear Ms. Starks,

This letter is in response to the ASMFC Shad and River Herring Technical Committee's (S/RH TC) request for a response to the stock status determinations for the Hudson River in the 2020 American Shad Benchmark Stock Assessment. Responses to the three questions from the S/RH TC are presented below.

- *Identify areas of concern identified in the assessment (e.g. stock status, data deficiencies preventing stock status determination, habitat issues)*

  The NYS DEC agrees with the stock status determinations for the Hudson River American shad stock. The following text provides additional information on the decline in Hudson River shad further supporting the depleted stock status determination:

  - **Overfishing:** The Hudson stock has experienced several overfishing events dating back to as early as the mid-1800's (Harper's Weekly 1872). When using commercial landings (Figure 1) as a proxy for abundance, the stanzas that occurred accurately track the overfishing events. The first peak in harvest occurred in 1880 followed by the first documented decline in 1896. According to the US Fish Commission (1896), this decline was attributed to increasing demand for shad and improving methods of capture. There was little to no fishing occurring from the turn of the 20th century up until the 1930's. High levels of sustained harvest, greater than one million kg annually, began in 1936 continuing through the WWII years until about 1950. The harvest during WWII, nearly ten years, ranged from 1.1 to 1.7 million kg. A sharp decline followed in the late 1940's. The 18 million kg of landings indicates the stock was very robust to allow such high sustained harvest and surprisingly left the stock large enough and with some resilience to recover. However, this recovery was short-lived, and the stock experienced another decline in the late 1950's as fishers returned home from the war to continue their business of fishing. Landings remained low through the 1960's and 1970's. During this time period, the Hudson was experiencing crucial habitat issues, including pollution and massive habitat loss which complicated and slowed recovery. Following the Federal Water Pollution Control Act Amendments of 1972 and the Clean Water Act of 1977, water quality in the Hudson improved and by 1980 a short-lived resurgence of landings occurred averaging 310,000 kg annually through 1988. The final decline, that persists today,

began in 1998. Hattala and Kahnle (ASMFC 1998) found the spawning stock experienced excessively high mortality and that mortality seriously reduced the abundance of adults. Production of young-of-year shad collapsed within a generation and since 2002, the stock has been in recruitment failure with little to no signs of recovery.

During the last decline, in addition to the traditional in-river fishery, a directed ocean commercial fishery for American shad developed in the mid to late 1980's continuing through the 1990's. This fishery likely developed to supplement income due to restrictions in coastal waters that were implemented for striped bass recovery during that time. In the early 1990's, noticeable changes (disappearance of larger fish, increasing annual mortality) began to occur in the Hudson and other coastal stocks (ASMFC 1998). Because of the difficulty in differentiating ocean harvest to individual stocks, the directed ocean fisheries were phased out from 1990 to 2005 (ASMFC 1999). However, following the ocean closure there was no recovery of the Hudson stock, and the continuing in-river fishery exacerbated the recruitment collapse. New York closed all fisheries for American shad in 2010.

Lastly, late winter and early spring mixed-stock fisheries in large coastal bays, such as Delaware Bay, continue to harvest the Hudson stock. Recent genetics studies (Waldman et al. 2014; Bartron et al. in prep) indicate 25-50% of shad captured in mixed-stock fisheries in Delaware Bay are Hudson stock depending on the location of capture and the type of genetic analysis applied. In addition to coastal bay harvest, incidental bycatch of American shad occurs in several Federal fisheries along the Atlantic coast. However, stock composition of this bycatch is unknown and cannot be assigned to an individual stock. Losses of shad to ocean commercial bycatch may have contributed to the most recent decline in the Hudson stock, but the magnitude of such losses is essentially unknown.

- **Habitat Loss:** The historical record of overfishing events was confounded by additional effects of in-river habitat loss and alteration which likely affected abundance of American shad in the Hudson River Estuary. Substantial destruction of shad spawning and nursery habitat occurred from the late 1800's through the mid 1900's from dredge and fill in the upper third of estuary during development and maintenance of the navigation channel from New York City to Albany/Troy (Miller and Ladd 2004). Over 4,500 acres of river bottom were destroyed or altered; this loss was likely a factor in shad decline in the late 1800's and early 1900's.

  Major habitat alteration ended in the 1950's and it is unlikely that it has been a factor in the most recent stock decline. However, such habitat loss may influence the rate of stock recovery. In addition to actual physical losses were pollution events such as the massive dissolved oxygen blocks in a large portion of the spawning and nursery habitat (Albany pool) and most likely in New York harbor in the 1960's through early 1970's (NYSDEC 1995). Declines in water quality in shad spawning and nursery areas have been suggested as a cause of recent shad decline in some east coast estuaries. However, this may not be occurring in the Hudson where water quality has improved since the implementation of the Clean Water Act in 1977.

Young American shad in the river are also lost to mortality due to various cooling water intakes. Cooling systems at some power generating stations have been converted to (Albany Steam to Bethlehem Energy Center), or built (Athens) as, closed cycle cooling. The NYSDEC is addressing take at all other water intakes.

- *Identify additional information not considered in the assessment stock status determination that provides more context on the stock, fishery, etc. (e.g. more recent years of data, SFMP metrics and performance, survey trends)*

NYS DEC feels that all available and appropriate information was considered in the stock status determination. Data from recent years, 2018-present, suggest no change in stock status relative to the assessment.

- *Suggest management or monitoring changes, or restoration efforts that would improve shad stock based on the information above*

Suggested management, monitoring changes and restoration efforts:

  - Reduce/eliminate harvest of Hudson shad in mixed-stock fisheries and ocean bycatch (near-term; high priority)
  - Identify stock composition of bycatch occurring in Federal fisheries and quantify impact to the Hudson stock (near-term; high priority)
  - Implement habitat restoration actions identified in the Hudson River Estuary Habitat Restoration Plan (Miller 2013) to restore high-quality spawning, nursery and refuge habitats for American shad (on-going, long-term; high priority)
  - Continuation of fishery closure until recovery targets (Hudson River American Shad Recovery Plan, in prep) are met and stocks are robust enough to support sustainable harvest (long-term; high priority)

Sincerely,

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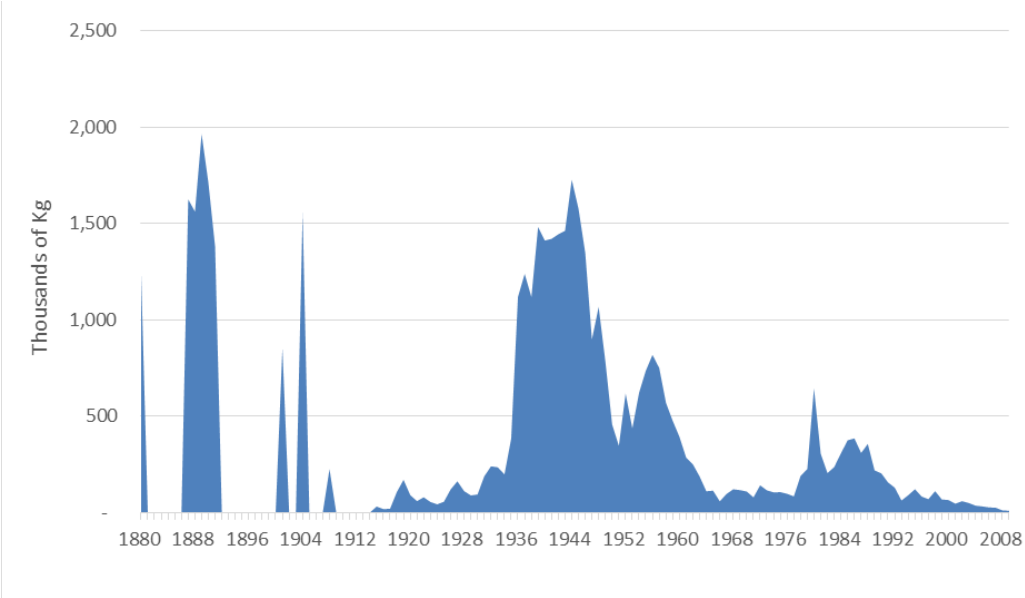

Figure 1. Historic commercial fishery landings of American shad in the Hudson River Estuary, 1880-2009.

State of Maine Response to TC questions Regarding Assessment, SFMP and Data Sources

Unknown American Shad Status and Assessment Findings

In August 2020 the American Shad Assessment Committee determined that American Shad population status in Maine is unknown. In August of the same year the River herring Management Board approved Maine's SFMP which allows recreational anglers a 2-fsih recreational limit per day using hook and line and maintains the commercial fishing closure for American Shad. The River Herring Technical Committee has requested that all states provide context that may explain inconsistencies between state SFMPs and the Assessment findings or provide additional justification for states SFMP's.

The two major areas of concern addressed in the assessment regarding Maine data were time series length and validity of count data collected at monitored fishways on Maine's larger rivers. There were additional concerns regarding collections and analysis of biological data from commercial and recreational fisheries.

The run count time series for several of Maine fishways do meet the 10-year data requirement used as the minimum standard for time series data used in ASMFC assessments. The issue is the State does not believe that the counts reflect the true abundance of American shad in the system. Many fishways throughout New England experience the same issue with lack of effective upstream passage of spawning shad and shad counts at fishways. The recent performance standards attempted at some FERC licensed fishway locations seek to achieve passage of 75-percent of the shad below dams with fishways. This indicates that dams remain a significant barrier to spawning shad populations and total run count numbers at dams with fishway may not be possible.

The Assessment Committee agreed with the State's determination and decided that they were not confident that the counts should be used to determine abundance under the rigor of the assessment document. The Committee made no conclusion regarding the abundance of shad in Maine.

Assessment Document vs Approved SFMP

In August 2020 the State of Maine submitted a statewide SFMP for American shad. The basis for the plan and the subsequent management actions are based on run counts at passage facilities throughout the state and the long-standing JAI (1979-2021) used to monitor annual production in the assessment.

Though the run counts are not comprehensive enough to determine stock status of individual systems, they do provide relative abundance estimates over long periods of time. These data, when analyzed with flow and water temperature, provide the ability to compare relative abundance and justification for the states 2 fish recreational limit. In general, statewide run counts continue to increase at locations where the state maintains counting locations. The JAI series information was used by the assessment committee and currently tracks juvenile production in the Merrymeeting Bay region

The management responses in the Maine SFMP are significant and will effectively close waters to any harvest should the state not meet the 25-th percentile or production metrics. The metrics are a reasonable measure of relative abundance and used to measure changes in abundance in several sport fisheries.

Calculation of Biological Metrics from Recreational and Commercial Catches

The State of Maine submits an annual request for de minimis status regarding American shad. The de minimis status granted through the review of the PRT and FMP process acknowledge

"*that the under the existing condition of the stock and scope of the fishery, conservation and enforcement actions taken by an individual state would be expected to contribute insignificantly to a coastwide conservation program required by a Fishery Management Plan or Amendment."*

The de minimis status provides relief to the state from having to collect biological data from commercial and recreational catches that would make insignificant contributions to the assessment or other management actions. The poor physical condition and low abundance of shad captured at many of our counting facilities prevent the responsible collection of biological data for age, sex, length, weight and mortality estimates. At some facilities the number of returns does not meet the sample number required to conduct the calculations.

Recommendation

The restoration efforts that would be most helpful would be removal of significant barriers to upstream passage. This may enhance production, increase abundance and provide more opportunity to collect biological data through additional sampling methods without taking a significant portion of the returns to a system. A statement by ASMFC or relevant document that the states could use during the FERC relicensing process or issuance of Water Quality Certificates would be helpful.

Commonwealth of Massachusetts Response to TC questions Regarding the American Shad Stock Assessment and Sustainable Fishery Management Plan

MA Division of Marine Fisheries – December 7, 2020

The Atlantic States Marine Fisheries Commission (ASMFC) Shad and River Herring Technical Committee (TC) requested that all states provide context that may explain inconsistencies between state American Shad (*Alosa sapidissima*) SFMPs and stock assessment findings or provide additional justification for states Sustainable Fishery Management Plans (SFMP). This response from the MA Division of Marine Fisheries (DMF) addresses questions over the unknown status shad in the Merrimack River.

ASMFC Shad and River Herring TC Questions

- *Identify areas of concern identified in the assessment (e.g. stock status, data deficiencies preventing stock status determination, habitat issues)*

The ASMFC American Shad Stock Assessment Sub-committee (SAS) determined in August 2020 that the American Shad population status in the Merrimack River is unknown. The SAS stated that there was not enough data to determine abundance status, and highlighted deficiencies with low age samples in some years that prevent a complete series of 3-year averages of mortality estimates. The SAS also noted the absence of a JAI index and an increasing trend in adult spawning run counts for 2005-2017.

- *Identify additional information not considered in the assessment stock status determination that provides more context on the stock, fishery, etc. (e.g. more recent years of data, SFMP metrics and performance, survey trends)*

The most recent Massachusetts Sustainable Fishing Plan for American Shad was approved by the ASMFC Shad and River Herring Management Board on February 9, 2019. The MA shad SFMP allows a recreational harvest with a 3-fish bag limit. The sustainability metric is derived from the adult shad lift count series at the Essex Dam from 1983-2017. The benchmark is 210 shad/lift day and serves as a spawning run threshold for management action. Three consecutive years below this benchmark will trigger consultation between MA Division of Fish and Wildlife and DMF to discuss reducing recreational harvest. The spawning run count series does not produce a biomass reference. However, it does provide a 38-year index of spawning adults with an increasing trend in the last 10 years. We view this as a successful and valuable time series that is supported by annual review from the multi-agency Merrimack River Technical Committee (MRTC) to maintain and improve data quality.

The MA SFMP also includes a warning threshold on shad mortality. Amendment 3 defined the shad mortality warning threshold as the level of total instantaneous mortality (Z) that resulted in a female spawning stock biomass that was 30% of the total female spawning stock biomass in a stock that experienced only natural mortality (Z = M). Amendment 3 provides benchmark values for New England shad runs of Z30 = 0.98 and A30 = 0.62 (annualized mortality). The Z30 benchmark was adopted by the SFMP as a warning threshold until a longer Merrimack River Z time series is recorded or further ASMFC recommendations are made. The total instantaneous mortality rate was estimated using the Chapman-Robson method, regression-based estimates, and catch curves from repeat spawning age data. The Chapman-Robson method is a probability-based estimator that has been shown to be more accurate and less biased than the linear regression-based catch curves, especially when sample size is small. Shad ages 5 through 10 were used in the analysis. The suitability of the 2001-2017 Merrimack River mortality

estimates may be limited by many factors including small sample sizes, a brief data series, combined genders in the estimate, and the assumption that all mortality is natural. The trend to date is that Merrimack River shad mortality was at or below the Z30 until 2013, when it increased above the threshold and has remained high since. While Z has recently increased, total length for both males and females has been relatively stable since 1999. The mortality warning threshold was not exceeded under the 2012 SFMP but has been exceeded each year since 2013. With the recent conditions of increasing spawning run stock, higher mortality estimates resulting from increased recruitment is not unexpected, although this dynamic should be reviewed and considered annually in the MA shad compliance report.

- *Suggest management or monitoring changes, or restoration efforts that would improve shad stock based on the information above.*

Merrimack River Shad Mortality. The time series for Merrimack River shad aging reported in the SFMP is from 1991-2017. The SAS identified concerns with low sample sizes of shad age samples impacting the time series and generation of 3-year averages. The most serious lapses in sample sizes occurred at the start of the time series and 2013. The MA SFMP identifies concerns with the time series and commits to working on these issues. Further, recent changes with state agency staff and staff serving on the Merrimack River Technical Committee allows the opportunity to discuss goals, and focus new staff on sampling targets and the need to improve the data quality and utility of mortality estimates.

Juvenile Abundance Index for American Shad. There have been no historical or recent efforts to create a juvenile abundance index on the Merrimack River. The State and Federal agencies with jurisdiction over shad in the Merrimack River have discussed an interest in developing a JAI index. Concerns have been expressed over the high variability inherent in shad JAI indices on the East Coast. Most importantly, no identified funding source is available to support a JAI index project and associated staffing. We also raise the question over whether a state that has been granted *de minimis* status for shad can be exempted from certain biological sampling requirements such as a JAI index.

Repeat Spawning Ratio. Ongoing shad scale aging will provide data on the ratio of repeat spawners in the spawning run. Repeat spawning ratio data are available for the Merrimack River from 2004-2017. The time series is too brief to allow the setting of a repeat spawning ratio benchmark or to discern any trends. This data collection will continue and be reported in the River Herring and American Shad ASMFC Compliance Report annually and considered further with the next SFMP review.

Restoration Efforts. Poor passage at mainstem dams and many tributaries without passage is presumed to be a significant limitation to increasing shad and other diadromous fish populations in the Merrimack River watershed. Ongoing annual review with hydropower dam owners are essential to identify operation and maintenance issues that can impact shad passage. The MRTC has annual pre and post-season meetings with mainstem hydro owners to review in-season actions and address issues. However, recommended improvements are not always adopted. These efforts will continue, and the concerns highlighted by the SAS review will contribute to fish lift objectives pursued by this inter-agency review.

The Pawtucket Dam, the second mainstem dam on the Merrimack in Lowell, MA, is currently in the relicensing process. The Pawtucket Dam has provided poor fish passage, especially for American shad, for decades and is seen as a major impediment to the restoration of alosine to the Merrimack River. Concurrently, management agencies involved with the Merrimack River are drafting a Comprehensive Plan for fish restoration in the watershed that will set target population levels and prioritize restoration efforts. This document should be finalized and filed with FERC in early 2021.

ROY COOPER
Governor

MICHAEL S. REGAN
Secretary

STEPHEN W. MURPHEY
Director

To: Caitlin Starks, ASMFC

CC: Katy West, Kathy Rawls, Chris Batsavage, Jeremy McCargo

From: Holly White

Date: November 6, 2020

Subject: NC Response to 2020 American Shad Benchmark Stock Assessment

On September 28, 2020 the ASMFC Shad and River Herring TC tasked members to provide a written response to the 2020 American Shad Benchmark Stock Assessment results for systems where harvest is allowed and the assessment determined the stock status to be unknown, unsustainable, or depleted. For North Carolina, the Tar-Pamlico River and Cape Fear River systems both received unknown stock status determinations. Both systems are managed under the 2018-2022 Sustainable Fishery Management Plan (SFMP) for North Carolina which allows for monitored recreational and commercial harvest. North Carolina accepts the stock status determinations for the Tar-Pamlico River and Cape Fear River systems. Despite the findings of the stock assessment, North Carolina does not recommend any changes to monitoring or management for these systems and supports continued use of the SFMP to monitor trends in adult abundance and harvest.

Tar-Pamlico River

Areas of Concern

The 2020 American Shad Benchmark Stock Assessment found the Tar-Pamlico River system adult total mortality rate and adult abundance to be unknown due to the lack of young-of-the-year data and no trend in the adult indices from 2005-2017.

1. Stock Status

From Section 3.15.8 Stock Status and Conclusions of the 2020 American Shad Benchmark Stock Assessment report:

Mortality

Juvenile mortality status is unknown due to lack of data to make this determination. The adult mortality status is also unknown as there was no estimate of female total mortality in 2017 and the delay-difference model experienced diagnostics problems and could not be used for status determination. The most recent three-year average female total mortality was 0.87 in 2007 which is below the Z40% threshold (1.07).

There was a declining trend in female mean length from a long-term data set (1979-2017), but no trend from an additional short-term data set (2000-2017) detected. There were no YOY

recruitment data to compare to mean length trend analyses.

Abundance
Abundance status is unknown. There were no YOY abundance data available and no trend detected in adult abundance since 2005.

2. Data Deficiencies Preventing Stock Status Determination
There is no YOY abundance data available for the Tar-Pamlico River system.

Additional Information Not Considered in the Stock Assessment

1. Recent years of data
In 2017, exploratory juvenile abundance sampling for striped bass using trawl and seine nets was initiated in the Tar-Pamlico and Neuse rivers using historical sampling locations (1977-1983) where possible. NCDMF will continue to develop and refine abundance surveys in the Tar-Pamlico and Neuse rivers to standardize sampling methods. Sampling in the Tar-Pamlico and Neuse rivers will occur, indefinitely, starting early June and will continue through late October at fixed seine and trawl locations. While the focus of the survey is to obtain juvenile striped bass, the survey may also intercept American shad. Therefore, we believe this survey may be of use for a YOY abundance, once a more robust set of data is available for evaluation.

2. SFMP Metrics
The Tar-Pamlico River is included under the 2018-2022 NC SFMP for American Shad with two sustainability parameters: female relative abundance and female relative F.

Relative abundance of female American shad is derived from the electrofishing survey in the Tar River. The annual estimates have been relatively stable over the time series except for two notably high years of abundance in 2003 (1.49) and 2004 (1.26). The index was below the threshold (0.384) in 2002, 2006, 2007, 2009, 2018 and 2019. Updates are unavailable for 2020 due to the Covid-19 pandemic and mandatory suspension of sampling by NCDMF and NCWRC due to concerns for staff and the public safety.

Estimates of relative F for female American shad derived from the electrofishing survey were below the threshold from 2003 to 2006. These estimates of female relative F exceeded the threshold in 2002, 2007, 2009, and 2013. Since 2013, the annual estimate has remained well below the threshold consistent with a decline in commercial landings.

Suggested Management or Monitoring Changes
North Carolina does not recommend any change to management or monitoring for the Tar-Pamlico system. A management response for striped bass has been in effect since March 18, 2019 prohibiting the use of all gill nets upstream of the ferry lines from the Bayview to Aurora Ferry in the Tar-Pamlico River and the Minnesott Beach and Cherry Branch ferry in the Neuse River (Proclamation M-6-2019). This prohibition directed by the N.C. Marine Fisheries Commission and was in response to Supplement A to Amendment 1 to the N. C. Estuarine Striped Bass FMP, and was intended to reduce striped bass fishing mortality, but essentially protected American shad as well by removing gill nets from the normal fishing grounds for American shad in the Tar-Pamlico River. In 2019, no American shad were commercially harvested from the Tar-Pamlico River, in 2020 only 129 pounds were harvested from the system.

Based on the current management response and the reduction in commercial harvest from the Tar-Pamlico River, the system is not in need of any additional management measures.

Cape Fear River

The 2020 American Shad Benchmark Stock Assessment found the Cape Fear River system adult total mortality rate and adult abundance to be unknown due to the lack of young-of-the-year data and no trend in the adult indices from 2005-2017.

Areas of Concern

1. Stock Status

From Section 3.17.9 Stock Status and Conclusions of the 2020 American Shad Benchmark Stock Assessment report:

Mortality

Juvenile mortality status is unknown due to lack of data to make this determination. Adult mortality status is sustainable as the three-year average catch in 2017 was less than the delay difference model median TAC estimate.

There was a declining trend in female mean length from a long-term data set (1984-2017), but no trend from an additional shorter-term data set (2001-2017) detected. There were no YOY recruitment data to compare to mean length trend analyses.

Abundance

Abundance status is unknown. There were no YOY abundance data available. There was an increasing trend in adult abundance (two data sets) detected since 2005.

2. Data Deficiencies Preventing Stock Status Determination

There were no YOY abundance data available for the Cape Fear River system.

Additional Information Not Considered in the Stock Assessment

1. Recent years of data

In 2017, exploratory juvenile abundance sampling using trawl and seine nets was initiated in the Cape Fear River and its tributaries using historical sampling locations (1975-1978) where possible. NCDMF will continue to develop and refine the abundance survey in the Cape Fear River to standardize sampling methods. Sampling in the Cape Fear River, including the main stem, Northeast Cape Fear, and between Lock-and-Dams #1 and #2, will occur, indefinitely, starting early June and will continue through late October at fixed seine and trawl locations. While the focus of the survey is to obtain juvenile striped bass, the survey may also intercept American shad. Therefore, we believe this survey may be of use for a YOY abundance, once a more robust set of data is available.

2. SFMP Metrics

The Cape Fear River is included under the 2018-2022 NC SFMP for American Shad with two sustainability parameters: female relative abundance and female relative F.

Relative abundance of female American shad from the electrofishing survey in the Cape Fear River was low from 2006 through 2011, and values were below the threshold (0.115). 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. Updates are unavailable for 2020 due to the Covid-19 pandemic and mandatory suspension of sampling by NCDMF and NCWRC due to concerns for staff and the public safety.

Suggested Management or Monitoring Changes

North Carolina does not recommend any management measures or monitoring changes for the Cape Fear River system based on assessment findings. Monitoring under the current SFMP is sufficient to detect any changes in abundance. Annual updates to sustainability parameters have not exceeded their thresholds since 2011 and 2012, respectively. Additionally, the 2020 Benchmark Stock Assessment noted that there is an increasing trend in adult abundance, likely a sign of improved passage at Lock and Dam 1.

South Carolina Department of
Natural Resources

Robert H. Boyles, Jr.
Director
Emily C. Cope
Deputy Director for
Wildlife and Freshwater Fisheries

TO: **Shad and River Herring TC**

FROM: **Bill Post**

DATE: **11/12/2020**

SUBJECT: **Response to Benchmark Stock Assessment**

The purpose of this document is to respond to requested questions regarding conclusions and recommendations made in the most recent benchmark stock assessment for American shad in South Carolina Rivers.

Winyah Bay

- *Identify areas of concern identified in the assessment (e.g. stock status, data deficiencies preventing stock status determination, habitat issues)*

Abundance

Abundance status is unknown. There were no Young of Year (YOY) abundance data available. There have been conflicting trends in adult abundance since 2005, with an increasing trend detected from the Black River Commercial CPUE and no trend detected from the Great Pee Dee River or Waccamaw River Commercial CPUE, further confounding assessment of abundance conditions in recent years.

Mortality

Juvenile mortality status is unknown due to lack of data to make this determination. The adult mortality status is also unknown, as the Delay-Difference models experienced diagnostics problems and could not be used for status determination.

There was a declining trend detected in female mean length from 1981-2015, but no YOY recruitment data to compare to mean length trend analyses.

- *Identify additional information not considered in the assessment stock status determination that provides more context on the stock, fishery, etc. (e.g. more recent years of data, SFMP metrics and performance, survey trends)*

Response

Due to the growing concerns to demonstrate sustainable fisheries in SC rivers, all fishery independent gill netting was relocated to the Santee and Waccamaw Rivers, to be used as "reference" rivers for the State. Those data (currently 2011-2020) will meet the minimum time series requirement and will be available for the next benchmark stock assessment.

Due to the growing concerns to demonstrate sustainable fisheries in SC rivers, electrofishing sampling for YOY juvenile shad began in 2011 and has occurred every year since. These data (currently 2011-2020) will meet the minimum time series (ten years) and will be available for the next benchmark stock assessment.

Santee Cooper System

- *Identify areas of concern identified in the assessment (e.g. stock status, data deficiencies preventing stock status determination, habitat issues)*

Abundance

Abundance status is unknown. There were no YOY abundance data available. There have been conflicting trends in adult abundance since 2005, with an increasing trend detected from the Cooper River Recreational Creel Survey and no trend detected from the Santee River Adult Gill Net Survey or Santee River Commercial CPUE, further confounding assessment of abundance conditions in recent years.

Mortality

Juvenile mortality status is unknown due to lack of data to make this determination. The adult mortality status is also unknown, as the Delay-Difference models experienced diagnostics problems and could not be used for status determination.

There were no YOY recruitment data to compare to mean length trend analyses.

- *Identify additional information not considered in the assessment stock status determination that provides more context on the stock, fishery, etc. (e.g. more recent years of data, SFMP metrics and performance, survey trends)*

Response

Due to the growing concerns to demonstrate sustainable fisheries in SC rivers, all fishery independent gill netting was relocated to the Santee and Waccamaw Rivers, to be used as "reference" rivers for the State. Those data (currently 2011-2020) will meet the minimum time series requirement and will be available for the next benchmark stock assessment.

Due to the growing concerns to demonstrate sustainable fisheries in SC rivers, electrofishing sampling for YOY juvenile shad began in 2011 and has occurred every year since. These data (currently 2011-2020) will meet the minimum time series (ten years) and will be available for the next benchmark stock assessment.

Ace Basin

- *Identify areas of concern identified in the assessment (e.g. stock status, data deficiencies preventing stock status determination, habitat issues)*

Abundance

Abundance status is unknown. There were no YOY abundance data available and no trend detected in adult abundance since 2005.

Mortality

Juvenile mortality status is unknown due to lack of data to make this determination. The adult mortality status is also unknown, as the Delay-Difference models experienced diagnostics problems and could not be used for status determination.

There were no mean length data available for trend analyses.

- *Identify additional information not considered in the assessment stock status determination that provides more context on the stock, fishery, etc. (e.g. more recent years of data, SFMP metrics and performance, survey trends)*

Response

Due to the growing concerns to demonstrate sustainable fisheries in SC rivers, electrofishing sampling for YOY juvenile shad began in 2011 and has occurred every year since. These data (currently 2011-2020) will meet the minimum time series (ten years) and will be available for the next benchmark stock assessment.

Savannah River

- *Identify areas of concern identified in the assessment (e.g. stock status, data deficiencies preventing stock status determination, habitat issues)*

Abundance

Abundance status is unknown. There were no YOY abundance data sets with appropriate time series available and no trend detected in adult abundance (two data sets) since 2005.
Mortality

Juvenile mortality status is unknown due to lack of data to make this determination. The adult mortality status is also unknown, as the Delay-Difference models experienced diagnostics problems and could not be used for status determination.

There were no mean length data available for trend analyses.

- *Identify additional information not considered in the assessment stock status determination that provides more context on the stock, fishery, etc. (e.g. more recent years of data, SFMP metrics and performance, survey trends)*

Response

Since this is a shared waterbody bordering SC and GA, both States share data in order to comply with sustainability requirements.

As part of an ongoing sampling program, GADNR conducts electrofishing for spawning adult shad in Augusta GA. This sampling program's dataset was recently approved by the ASMFC S&RH TC as GA's method to demonstrate sustainability. These data (currently 2010-2020) will meet the minimum time series (ten years) and will be available for the next benchmark stock assessment.

Due to the growing concerns to demonstrate sustainable fisheries in SC rivers, electrofishing sampling for YOY juvenile shad began in 2011 and has occurred every year since. These data (currently 2011-2020) will meet the minimum time series (ten years) and will be available for the next benchmark stock assessment.

- *Suggest management or monitoring changes, or restoration efforts that would improve shad stock based on the information above.*

Suggested Research Recommendations in the benchmark stock assessment

Commercial Landings and Effort

- Continue and improve compliance with mandatory catch and effort reporting from commercial fishery for all American shad fisheries prosecuted in South Carolina waters.

- Continue the "volunteer CPUE" series to compare with CPUE series developed from comprehensive mandatory reporting database.

- Convert volunteer commercial catch and effort from field reports into digital format so raw data are available for future analysis.

- Collect age, length, weight, and spawning history information from shad caught in commercial fisheries in the Santee River, Winyah Bay system, Savannah River, and Edisto River.
- Conduct an age validation study of American shad from South Carolina rivers (especially, Santee River, Winyah Bay system, Savannah River, and Edisto River).

Tagging

- Continued monitoring of river systems (Santee River, Waccamaw River, and Edisto River) on rotating basis (yearly rather than a 3-year schedule).

• Improvements to tagging design (e.g., develop high-reward design, telemetry studies to get estimates of fall back, double tagging study to estimate tag loss, and tag- mortality study) to improve relative exploitation estimates. Conduct tagging studies for duration of shad migration and continue to collect effort information from sampling collections (e.g., soak time, net length, and mesh size) to permit development of CPUE calculations.

Creel Surveys

• Continue to conduct creel surveys in rivers with notable recreational fisheries (Savannah River and Cooper River). If necessary, conduct creel surveys on a rotating basis.

Fish Passage

• Develop species specific upstream and downstream passage efficiency at all rivers with priority given to Santee-Cooper system dams.

• Develop species specific counts at Pinopolis fish-lock on the Cooper River. Juvenile Abundance Index

• Continue to develop reliable indices of juvenile abundance.
General

• Collect environmental covariates (tidal stage, flood stage, flow rate, water temperature, cloud cover, water clarity, annual precipitation, etc.) to aid development of CPUE indices.

Response by priority

Many recommendations in the list above have already been initiated, but simply did not meet the minimum time series requirement to be included in the most recent benchmark stock assessment. These datasets will continue and should be included for the next benchmark stock assessment.

SC recognizes issues with using solely scales for aging and has begun to initiate studies involving both otoliths and scales with hopes of examining known errors associated between these structures. With any luck, correlation can be developed between the two, allowing use of decades of collected scale age data. Additionally, we will begin collecting and examining otoliths for aging purposes rather than scales.

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
WILDLIFE RESOURCES DIVISION

MARK WILLIAMS
COMMISSIONER

TED WILL
DIRECTOR

Memo

TO: **Shad and River Herring TC**

FROM: **Jim Page**

DATE: **12/10/2020**

SUBJECT: **Shad Management on the Altamaha and Savannah Rivers**

By way of this memo and pursuant to the request by ASMFC for additional information on information that may have impacted the results of the most recent shad stock assessment, I would like to offer the following information for the Savannah and Altamaha Rivers:

- *Identify areas of concern identified in the assessment (e.g. stock status, data deficiencies preventing stock status determination, habitat issues)*

Savannah River: The assessment findings were that the population had an "unknown status" but harvest remained allowed through the SFMP. Specifically, conclusions were not that abundance was not declining but rather that it was unknown and no trend was detected. No significant data deficiencies for adult fish were identified for the assessment period; however, in recent years the Commercial drift-net CPUE data that serves as the management trigger on the Savannah River has become less available as attrition in the fleet has resulted in a decline in commercial participation (0 reported fishing effort in 2019 and 2020 seasons) and a switch in preferred gear (from drift-net to set-net). As such, this drastic decline in recent years has certainly impacted calculated CPUEs from where they would have been several years ago when many more fishermen were involved. To combat this, the TC approved us in June 2020 to switch our management trigger from the commercial CPUE to a CPUE derived from fishery-independent efforts we conduct via electrofishing at the New Savannah Bluff Lock and Dam (NSBLD). These efforts at the NSBLD have been ongoing since 2010 and we believe will be a much better indicator of stock status, as they won't rely on an ever-changing commercial fishery presence. Additionally, YOY datasets were excluded in part due to insufficient time series.

Altamaha River: The assessment findings were that the population had an "unknown status" but harvest remained allowed through the SFMP. Specifically, conclusions were not that abundance was not declining but rather that it was unknown due to conflicting trends (one increasing; one unknown. Georgia has maintained a tagging survey for American shad on the Altamaha for 38 years, along with collecting commercial landings, monitoring the commercial fishery via observers, and monitoring the recreational fishery via creel surveys. Suggestions were made on potential changes/improvements for the tagging study, and GADNR staff will consider and deliberate whether to implement any/all of these recommendations.

FISHERIES MANAGEMENT SECTION
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- *Identify additional information not considered in the assessment stock status determination that provides more context on the stock, fishery, etc. (e.g. more recent years of data, SFMP metrics and performance, survey trends)*

Savannah River: Young-of-year (YOY) data was not included from the Savannah River in the most recent assessment. This exclusion is not based on known or suspected declines in juvenile abundance, but rather from a current lack of the time series (e.g. <10 years) and due to inconsistencies in the dataset. Since 2010, we (GADNR) have conducted seine surveys during the months of July – Sept to collect data on YOY shad. While these efforts have provided us with valuable data when we are able to complete them, there have been many instances when we were unable to conduct sampling. When river levels are high, the sandbars on which we conduct seining are covered in water, and thus we cannot access those sites with seine gear. During extended high-water events, like we've had multiple times since 2010, we are unable to collect data, and thus gaps in the data are created.

Altamaha River: For the exact reasons applicable to the Savannah River (above), YOY data was not included from the Altamaha River in the most recent assessment. Again, this exclusion is not based on known or suspected declines in juvenile abundance, but rather from a lack of time series (<10 years) and inconsistencies in the data set. Since 2010, we (GADNR) have conducted seine surveys during the months of July – Sept to collect data on YOY shad. Just like in the Savannah River, these efforts have provided us with valuable data when we are able to complete them. However, there have been many instances when we were unable to conduct sampling, most notably when river levels are high and sandbars are covered, thereby preventing access for sampling with seines.

- *Suggest management or monitoring changes, or restoration efforts that would improve shad stock based on the information above.*

Outside of the suggested tweaks recommended by the assessment team (e.g. tagging survey), we (GADNR) are continuing to evaluate and discuss possible changes to improve our management of shad. Collectively, we feel we are doing a good job in many aspects of monitoring the shad stock in our rivers, though we are certainly open to improvement. One potential improvement we are considering is the addition of collecting otoliths in addition to scales for aging purposes. As our SFMP indicates, we will continue to keep a keen eye on our shad population and should we observe declines that trigger management measures we will respond accordingly so as to provide protection to our shad stock. It is important to note that sustainability of our stocks continues to be our primary focus.

Conclusion:

On behalf of the GADNR we appreciate your consideration of the aforementioned explanations and hope the information presented above will be helpful in better explaining our data gaps and provide a clearer understanding of what we know. We remain dedicated to ensuring the sustainability of our shad population and will continue to use a variety of tools to best manage our stocks. We thank you for your continued efforts to work alongside us in managing these important resources.

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Memo

13 November 2020

TO: ASMFC Shad and River Herring Technical Committee

FROM: Reid Hyle, Florida Fish and Wildlife Conservation Commission

RE: Unknown Stock Status of American Shad and the Sustainable Fishing and Management Plan on Florida's St. Johns River

This memorandum serves as the response from Florida to the ASMFC Shad and River Herring Technical Committee regarding the Benchmark Stock Assessment finding of unknown status for an American Shad population subjected to harvest under a SFMP; St. Johns River Florida.

- *Identify areas of concern identified in the assessment (e.g. stock status, data deficiencies preventing stock status determination, habitat issues)*

The benchmark stock assessment used two trend datasets to assess the St. Johns River Florida stock of American Shad; these were the annual young of the year relative abundance 2007-2017 and adult spawning stock relative abundance 2003-2017. The assessment also evaluated trends in total length of spawners. The conclusion was that the abundance status of the stock could not be determined. The spawning stock index had a significant positive trend from 2005 to 2017. The JAI showed no trend. Power in the surveys was deemed adequate to detect a 50 percent decline in abundance over 10-years so we feel that the population was likely stable or improving during the assessment period since neither index declined over time and mean fork length of males and females both increased.

Additional data that could aid in stock status determination are being collected. Spawner otoliths are available for age composition and size at age starting in 2011 and will be able to provide a time series > 10 years at the next assessment. The collection still needs to be read by two readers with work to ensure good precision, accuracy, and validation. These data will not directly inform mortality estimates for this semelparous population but will provide improved resolution of the maturity schedule and help identify strong year classes.

The assessment found that 90 percent of documented historical spawning habitat is still available to the St. Johns River, FL population below the lowermost barrier. Historical spawning grounds extended from river kilometer 230 to 433 with the most important grounds being between 275 and 360. Approximately 14 kilometers of marginal habitat lies above the barrier and habitats between 230 and 265 were subjected to channelization in the 1930s and 1940s. Most of the core spawning grounds identified in the 1960s and 1970s remains intact. The primary concern with habitat now and going forward is water quantity and quality; climate change and population growth may alter flow patterns in the St. Johns River which is the southernmost spawning population on the Atlantic coast. The pending update to the habitat plan will reflect threats from changes in flow, temperature, and sea level rise.

- *Identify additional information not considered in the assessment stock status determination that provides more context on the stock, fishery, etc. (e.g. more recent years of data, SFMP metrics and performance, survey trends)*

The modern creel survey dataset began in 2011 and was too short to use in the benchmark assessment. Available data through 2020 do not indicate an increase in total effort or harvest (Figures 1 and 2). Angler CPUE has remained stable and has perhaps been higher than was reflected in the 2007 stock assessment wherein there was a recommendation to set a CPUE based restoration target (Figure 3). Data from this time series could be used to ensure that harvest does not increase relative to the fishery independent index of abundance.

The benchmark assessment did state that biological data should be collected from the recreational fisheries where harvest is permitted. That is not feasible for the St. Johns River recreational shad fishery because the creel survey only encounters one or two trips per year that have shad in their possession.

The fishery independent index data for the spawning stock and young-of-the-year could be improved by an increase in statistical power. Samples are collected from a stratified random design which is appropriate but standardization for environmentally driven variance in catchability could be improved. At this time, we feel that the indexes are adequate for a conservative conservation trigger as specified in the SFMP where three consecutive years below the 25th percentile triggers management review and/or action.

- *Suggest management or monitoring changes, or restoration efforts that would improve shad stock based on the information above.*

There is no immediate management change planned at this time. The most recent years of index data are being reviewed because the spawning stock index has been in decline since 2015 (Figures 4,5,6). The juvenile abundance index has remained well above the 25th percentile of that series for all recent years. We are reluctant to attribute the decline in spawning stock abundance to recreational fishing because there has been no increase in effort, catch, or harvest.

Data from the YOY index indicate that flow during the spawning season is the biggest driver of recruitment to the juvenile stage in this system. Age data need to be refined and finalized because the preliminary data suggest that the strong YOY index in 2010 noted in the benchmark assessment was dominate in the spawning stock from 2013 to 2016. These relationships need to be modelled to improve our understanding of the stock-environment-recruitment relationship for this population absent evidence of significant in-river mortality from the fishery.

We also do not know what impact mixed stock fisheries and ocean bycatch are having on sub-adult St. Johns River American Shad. It is notable that St. Johns River, FL shad were recorded from the Delaware Bay fishery.

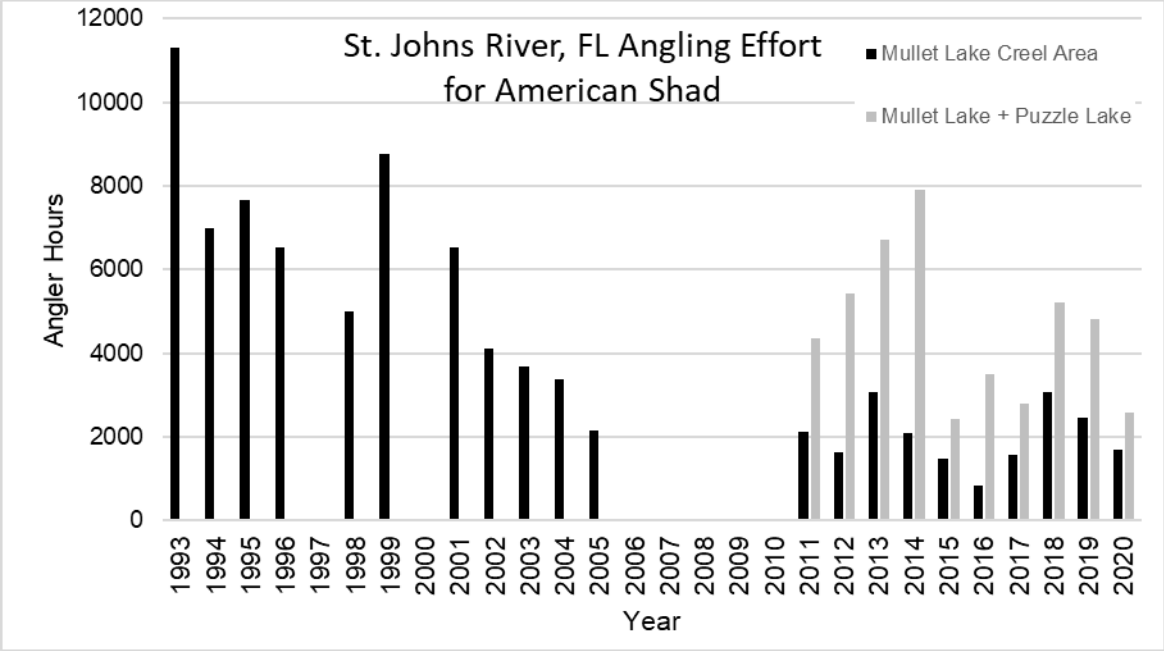

Figure 1. Recreational fishing effort for American Shad in the St. Johns River, FL from 2003 through 2020. A roving creel focused on river kilometer 285 to 298 from 1993 to 2005. An access point creel from 2011 covers river kilometers 278 to 298 via the primary two access points for that stretch of river. The access point creel added the "Puzzle Lake" stratum which is served by a single access point.

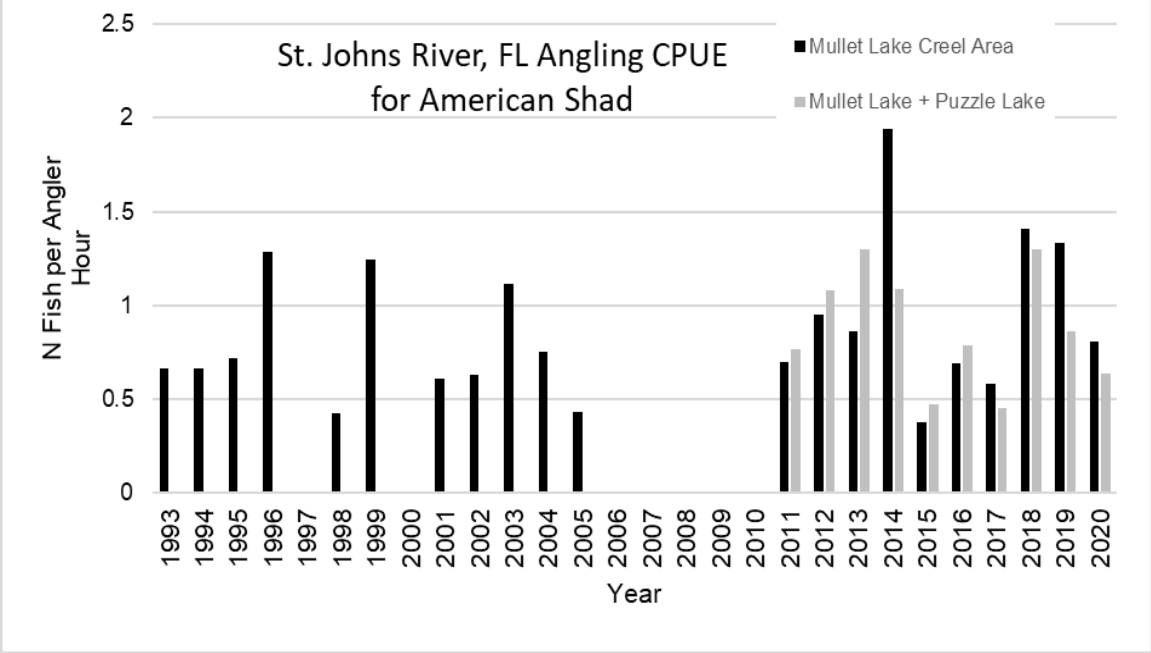

Figure 2. Recreational fishing catch per unit effort for American Shad in the St. Johns River, FL from 2003 through 2020. A roving creel focused on river kilometer 285 to 298 from 1993 to 2005. An access point creel from 2011 covers river kilometers 279 to 298 via the primary two access points for that stretch of river. The access point creel added the "Puzzle Lake" stratum which is served by a single access point.

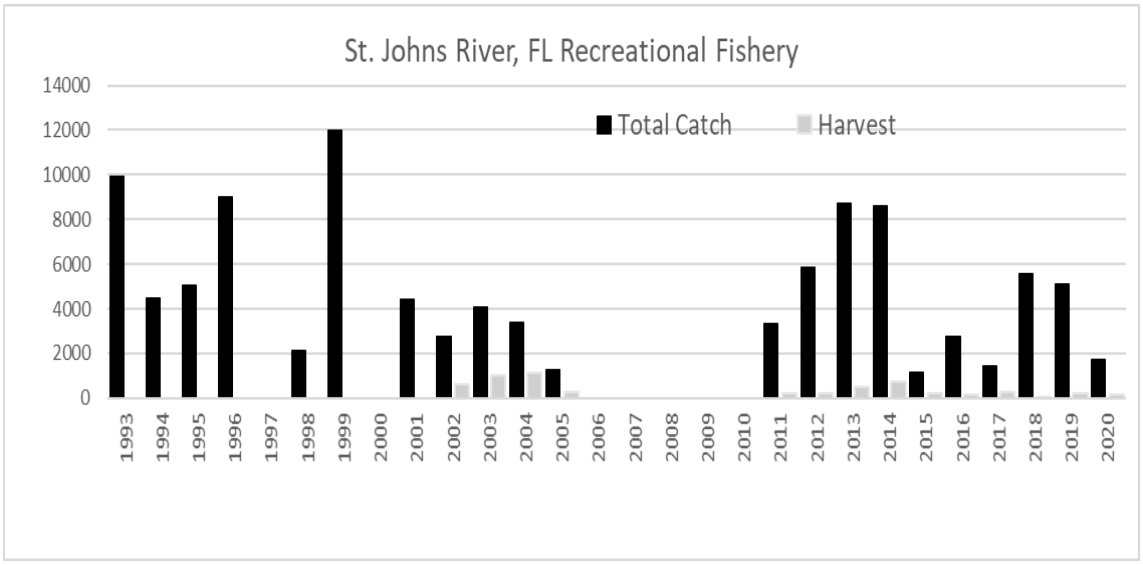

Figure 3. Total catch and harvest of American Shad from St. Johns River, FL from 2003 through 2020. A roving creel focused on river kilometer 285 to 298 from 1993 to 2005. An access point creel from 2011 covers river kilometers 279 to 298 via the primary two access points for that stretch of river. The access point creel added the "Puzzle Lake" stratum which is served by a single access point.

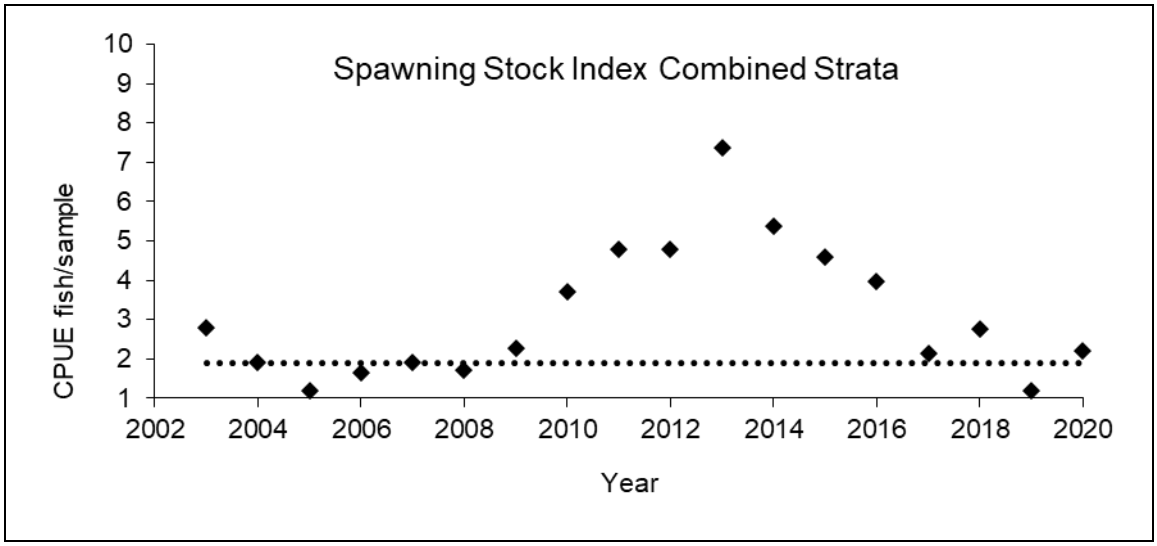

Figure 4. Spawning stock index (geometric mean) from the electrofishing survey of the St. Johns River combining both sampling strata. The 25th percentile of survey years 2003-2017 is set as the threshold in the SFMP.

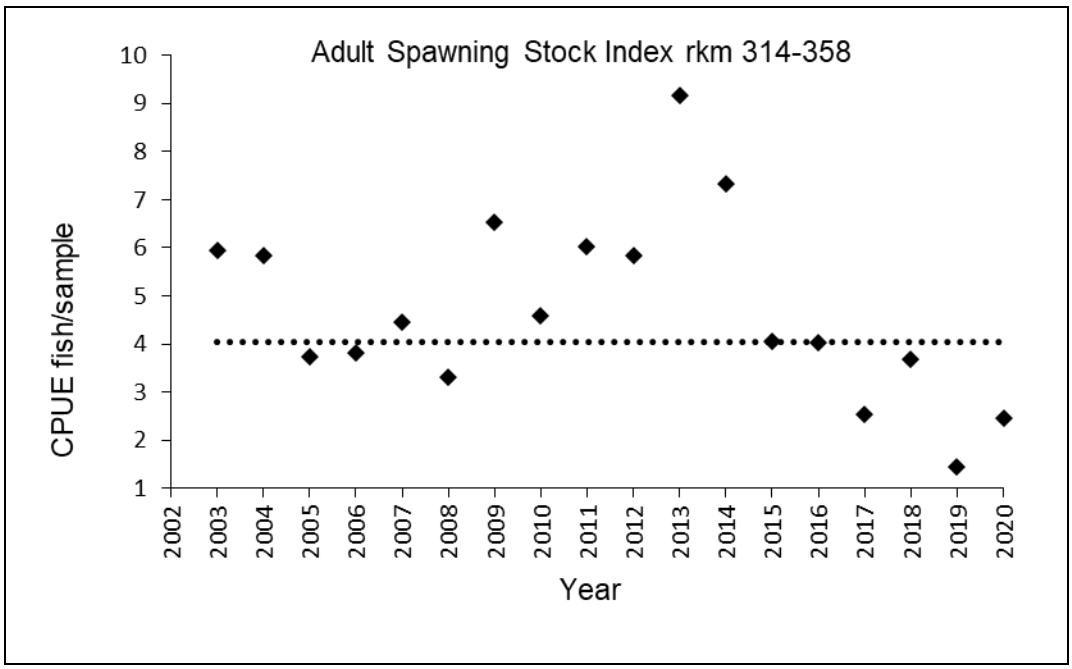

Figure 5. Spawning stock index (geometric mean) from the electrofishing survey of the St. Johns River in the upstream stratum (rkm 314 -358) in the St. Johns River. The 25th percentile of survey years 2003-2017 is set as the threshold in the SFMP.

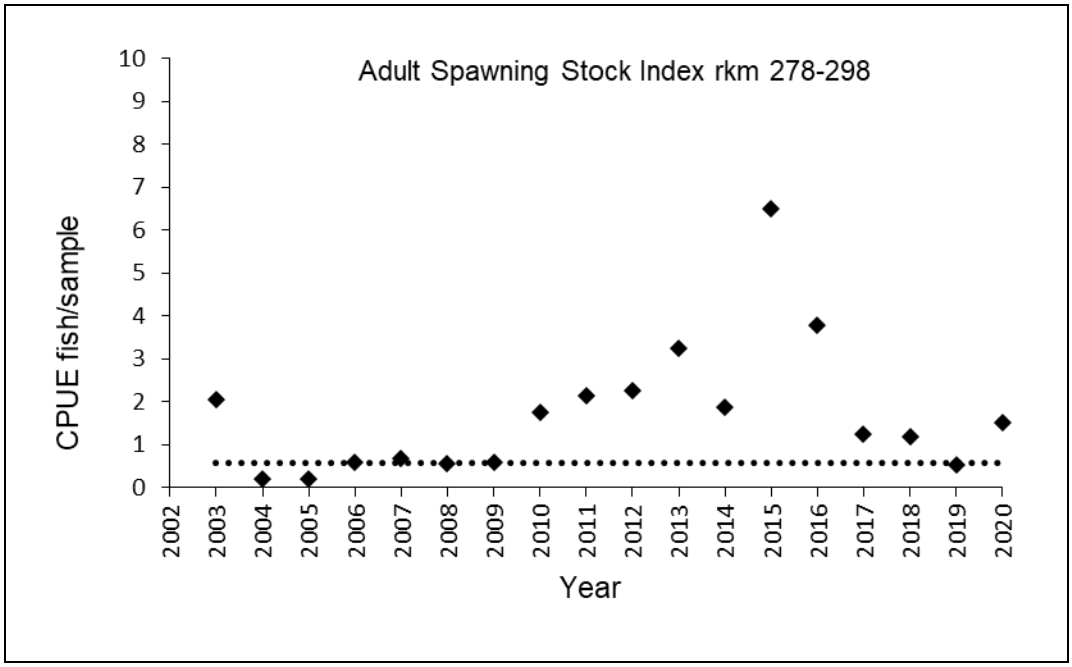

Figure 6. Spawning stock index (geometric mean) from the electrofishing survey of the St. Johns River in the downstream stratum (rkm 278-298) in the St. Johns River. The 25th percentile of survey years 2003-2017 is set as the threshold in the SFMP.

Atlantic States Marine Fisheries Commission

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MEMORANDUM

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

FROM: **Shad and River Herring Technical Committee**

DATE: **January 5, 2020**

SUBJECT: **Technical Committee recommendations on improvements to Amendment 2 and 3**

In October, 2017, the Board tasked the Shad and River Herring Technical Committee (TC) with developing proposed improvements to Amendments 2 and 3 with regard to the following items:

1. *Management and monitoring of rivers with low abundance and harvest of shad and river herring*
2. *Standardization of Sustainable Fishery Management Plan (SFMP) requirements: content, metrics, and management responses to triggers*
3. *Incorporation of stock assessment information into SFMPs and discussion on the timeline for renewing plans*
4. *Clarification of de minimis requirements as they pertain to SFMPs*
5. *Review of the number of years of data are required before developing a SFMP*

In 2019, the TC Task Group, a subset of the TC, was formed to address this task. The Task Group met via conference call and webinar several times during 2020 to develop draft recommendations for full TC review. Draft recommendations were presented to the TC and finalized during a webinar meeting on November 10, 2020. The final recommendations from the Technical Committee are included below, organized by topic.

Technical Committee Recommendations

1. Management and monitoring of rivers with low abundance and harvest of shad and river herring

The TC does not recommend any changes to the Fishery Management Plan (FMP) to address commercial fisheries (i.e. directed commercial harvest should always require an approved SFMP). However, the group recommends clarification on management of recreational fisheries in systems with unknown or low abundance and harvest.

The TC recommends the FMP clarify that management of recreational fisheries should be dependent on harvest and monitoring information. The following matrix summarizes the categorization recommended by the TC, which is further explained below.

		Data to support SFMP	
		Sufficient	Insufficient
Rec. Harvest	None (Species Absent)	NA	AMP
	Unknown (Species Present)	AMP / SFMP	Catch & release
	Known/ Suspected	SFMP	Catch & release

- For river systems with known populations of river herring/shad, known or suspected recreational harvest of river herring/shad, and sufficient system-specific monitoring data (FI or rec/commercial FD), the state or jurisdiction must either 1) close/implement catch and release only regulations; or 2) allow recreational harvest under a Board-approved SFMP with appropriate sustainability metrics, monitoring, and management responses. "Known" harvest is that which is recorded in official surveys or reports, whereas "suspected" harvest is identified through anecdotal or historic information in systems without official monitoring of recreational harvest. The TC would be responsible for determining whether monitoring data are sufficient or insufficient for their proposed uses.
- For systems with known populations of river herring/shad, no known or suspected harvest of river herring/shad based on recreational monitoring data, the state or jurisdiction must either 1) close/implement catch and release only regulations; 2) allow recreational harvest under a Board-approved SFMP with appropriate sustainability metrics, monitoring, and management responses; or 3) allow recreational harvest under a Board-approved Alternative Management Plan (AMP) until any recreational harvest is confirmed (using an AMP would not require a sustainability metric; recommendations for AMP requirements are provided later in this memo).
- For systems with known small populations of river herring/shad, no known or suspected harvest of river herring/shad (but without sufficient system-specific monitoring), the state or jurisdiction must either 1) close/implement catch and release only regulations; 2) allow recreational harvest under a Board-approved SFMP with appropriate sustainability metrics, monitoring, and management responses; or 3) allow recreational harvest under a Board-approved AMP until any recreational harvest is confirmed (using an AMP would not require a sustainability metric).
- For systems with no known populations of river herring/shad, and consequently no suspected harvest of river herring/shad, and no fishery-independent data for river herring/shad, the state or jurisdiction must either 1) close/implement catch and release only regulations; or 2) allow recreational harvest (or remain unregulated) under a Board-approved AMP. If river herring/shad were to become present, the state must resubmit the proposal to the TC with updated information and rationale (similar to the situation for the previous bullet).

2. Standardization of Sustainable Fishery Management Plan (SFMP) requirements: content, metrics, and management responses to triggers

The TC recommends additional language be added to the FMP to strengthen the SFMPs in several areas: A) the level of detail required in SFMPs on the management response that would be implemented should the stock fall below a defined sustainability target or threshold, B) when a state may relax restrictions implemented in response to a stock falling below the sustainability target/threshold, and C) management of interjurisdictional waterbodies. The TC did not recommend additional requirements be placed on the type of sustainability metrics that can be used in SFMPs. The group agrees that states/jurisdictions should be able to propose the most appropriate metrics for their specific systems, which would then be subject to TC evaluation and Board approval.

A. Management responses: Currently, Amendment 2 states that "If a stock is below optimum level the management plan must detail restrictions that will be enacted to allow for an increase in spawning stock abundance and juvenile recruitment" (p. 92). Amendment 3 includes an approved framework for SFMPs, which includes "discussion of management measure(s) to be taken if sustainable target is not achieved within indicated timeframe" (p. 41).

The TC recommends the following language be included in the FMP for both shad and river herring; the underlined portions are modified from the original language to provide more detail on acceptable management responses and the process for notifying the Board and implementing responses:

> "*States and jurisdictions must also submit a sustainable fishery management plan (SFMP) that describes how the fishery will be conducted and annually monitored in order to show that the sustainability target(s) are being achieved. The frame of reference for determining the optimum level at which to set the sustainability target(s) will vary from system to system, but should be based on an appropriate time scale. States should develop their sustainability targets within this general framework. The Technical Committee is responsible for developing a standard optimum level and timeframe basis.*
>
> *If a stock is at optimum levels, then that level will need to be sustained. The SFMP must detail restrictions that will be enacted to allow for an increase in spawning stock abundance and juvenile recruitment if a stock is, or falls below, the optimum level. Such restrictions may include any of the following: fishery closures, harvest or effort restrictions, catch and release only regulations (for recreational fisheries), season changes, area closures, gear restrictions, etc. A plan may provide multiple options for restrictions that will be enacted if a stock falls below the optimum level, however, each option should allow for an increase in spawning stock abundance and juvenile recruitment.*
>
> *If a stock falls below the sustainability target or threshold identified in the SFMP, the state must notify the Board in the next annual compliance report, and pursue implementation of the specified management response for the following calendar year."*

B. Relaxing management restrictions: The TC also recommends the FMP include language on when a state may relax restrictions implemented in response to a stock falling below the sustainability target/threshold. Currently the Amendments include language to this effect: "Proposals to reopen closed fisheries may be submitted as part of the annual Compliance Report, and will be subject to review by the Plan Development Team, Technical Committee and Management Board." The TC recommends the following addition:

> "*If a state has implemented a management restriction in response to the stock falling below the sustainability target(s), the management restriction must stay in place until the sustainability target(s) have been met for at least 5 consecutive years*."

C. Interjurisdictional management guidance: The TC also recommends that the FMP include additional guidance on management of waterbodies shared by one or more jurisdictions. The current Amendment 2 language states "Targets for river systems managed by more than one state/jurisdiction should be cooperatively developed" (p. 92). Amendment 3 states "For states and jurisdictions which share a river or estuary, agencies should include those monitoring programs conducted or planned by the agencies, applicable agency regulations, and habitat and habitat threats applicable to the state or jurisdiction's waters. In shared water bodies where there is a management cooperative, the cooperative or a member state or jurisdiction can be appointed to write the Implementation Plan" (p. 40).

The TC suggests the following change for both species:

> "*Targets for river systems managed by more than one state/jurisdiction should be cooperatively developed, such that shared systems are not managed by each jurisdiction using unique targets and/or monitoring data. One shared management plan may be submitted cooperatively by multiple jurisdictions sharing one system, including details on management measures and monitoring for/by each jurisdiction. Alternatively, one jurisdiction may be appointed to submit the plan for a shared*

system; for example, if one state/jurisdiction is the primary source of fishery-dependent and/or fishery-independent data for a shared system, that state may include the system in their state management plan, and include information for the other jurisdictions which share waterbodies. When possible, fisheries conducted in shared water bodies by harvesters permitted by different jurisdictions should be subject to consistent management measures."

3. Incorporation of stock assessment information into SFMPs and discussion on the timeline for renewing plans

To address this item, the Task Group recommended that the TC compile information on all current monitoring programs by species and system, and then develop recommendations for improvements to data for use in SFMPs and assessments. Some concern has been expressed among TC members that for many systems there is inconsistency between the information used to assess stock status through the stock assessment and that used to develop sustainability metrics for SFMPs. This issue is also being addressed as part of the August 2020 Board task to identify paths forward to improve shad stocks. The TC will continue to review required and ongoing monitoring efforts to improve data available for SFMPs and stock assessments.

The TC does not recommend a change to the five year timeline for renewing SFMPs and AMPs.

4. Clarification of de minimis requirements as they pertain to SFMPs

The TC does not recommend any changes to the current *de minimis* criteria and exemptions for states with *de minimis* status. Currently, under Amendments 2 and 3 states that report commercial landings of river herring or American shad, respectively, that are less than 1% of the coastwide commercial total are exempted from sub-sampling commercial and recreational catch for biological data.

5. Review of the number of years of data are required before developing a SFMP

The Task Group discussed how many years of data are appropriate in order to use a data time series to establish a sustainability metric, and made draft recommendations based on the biology of the species and statistical value. The following recommendations were fully supported by the TC.

- For shad, a minimum of 10 years of data should be required to establish a primary sustainability metric in an SFMP or AMP. The TC may have some discretion in evaluating state proposals that do not have 10 consecutive years of data.
- For river herring, the standard for acceptable time-series length for data being used to establish an SFMP metric should be 10 years. If additional information is provided to justify the use of a shorter time-series for establishing an SFMP metric, the TC may accept a time series trend of 7-9 years, with consideration of exploitation rate, stock size, or other relevant factors.

Additional Draft Recommendations

Beyond the five areas identified in the original Board task, the TC recommends some additional improvements to the FMP, summarized below:

- The TC recommends that additional language be included in the FMP to provide clear guidance on the use of AMPs. The TC recommends that AMPs must include the following components:
    - A statement of rationale or justification explaining why an SFMP cannot be used (e.g. data availability)

- Justification that the proposed management program will be conservationally equivalent to catch and release only regulations (e.g. there is no suspected harvest in the system(s) due to very low abundance based on fishery independent data or habitat limitations, creel survey data has not shown any harvest of species, etc.)
    - Explanation of how the state will determine if or when an AMP is no longer appropriate, including description of the data sources that will be monitored, and the trigger that will be used based on those data sources (e.g. 3 years of recorded harvest, or a defined level of abundance from surveys)
- Description of the management response that will be implemented if this trigger is met. (E.g. If harvest is documented through a creel survey for 3 consecutive years, catch and release only regulations will be implemented statewide or for specified systems).
- If a management trigger identified in the AMP is met, the state must notify the Board in the next annual compliance report, and pursue implementation of the specified management response for the following calendar year.

- In previous TC and Advisory Panel meetings, the committees have considered the idea of allowing limited recreational harvest in systems without an SFMP/AMP using a low statewide bag limit. <u>The TC does not recommend allowing any recreational harvest to occur on systems that are not managed through an approved SFMP or AMP.</u> The rationale is that unmonitored systems could experience unchecked recreational fishing pressure which could be detrimental to small stocks. The recommendation is that if a state wishes to apply a statewide recreational bag limit, the state must have an approved SFMP or AMP, and all unmonitored systems must be subject to management responses (e.g. closures, harvest restrictions) that are triggered by available sustainability metrics. For example, if a state has a statewide recreational bag limit, the SFMP should require the closure of recreational harvest (e.g. catch and release only regulations) for all unmonitored systems if one monitored system falls below the sustainability target.
    - <u>The TC recommends that AMPs allowing statewide recreational bag limits or no recreational regulations must include a trigger (e.g. observed recreational harvest, or increase in fishery independent abundance index) to implement catch and release only regulations or propose an SFMP (if sufficient data is available).</u>

Maine Department of Marine Resources

American Shad Habitat Plan

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Introduction

The 2020 Atlantic States Marine Fisheries Commission's American Shad Stock Assessment and Peer Review Report provides an extensive review of available literature and discussion on the topic of fish passage (ASMFC 2020). Specifically, it highlights the issues with lack of evaluation and performance from decades-old approaches, facilities designs/operations that are not effective, and therefore cannot reasonably be expected to achieve management and restoration goals without significant changes. The Assessment Report also provides an important quantitative modeling approach examining shad habitat and passage barriers, and the need to address status quo fish passage performance. The impacts of these barriers and status quo passage are described and also modeled as effects on spawner population size under three scenarios, 1) no barriers, 2) first barrier with no passage, and 3) realistic fish passage performance measures applied to barriers (e.g., upstream passage efficiency of 50%).

The Assessment Report used standardized data and modelling approaches that quantified the impacts of barriers and fish passage as significant in all three management areas examined based on shad life history and habitat (New England, Mid-Atlantic, and South Atlantic). The assessment determined that overall, dams completely or partly block nearly 40% of the total habitat once used by American Shad. The model results of the "no barriers" scenario yielded an estimated spawner production potential 1.7 times greater than that yielded by the scenario assuming no passage at the first barrier: 72.8 million versus 42.8 million fish. The results of the third model scenario, which applies "realistic" (i.e., current) fish passage efficiencies, resulted in a gain of less than 3 million fish. Conclusions include "losses in (spawner production) potential are significant in each state and region." The Assessment Report provides a strong justification for the need and benefits of requiring improved fish passage performance measures. Additionally, meeting such improved passage performance standards is now an achievable goal given the current state of knowledge on fish behavior, swimming performance, and fish passage engineering expertise.

This report specifically provides information for the major known American shad spawning and young-of-year rivers: the Saco, Androscoggin, Kennebec (and Sebasticook), and Penobscot rivers. The process of providing upstream and downstream passage for all anadromous fish is an ongoing effort by the State of Maine and its federal, state, and private partners. There may be ongoing, or recently completed restoration efforts not covered in this document while the effectiveness of these projects is assessed. Information about general threats, data availability, current work and recommended actions are provided in the State-Wide Information section.

State-Wide Information

Available Habitat

State-wide, there are twenty-three identified American shad rivers with over 2545 river kilometers of potential habitat. Currently only 1,611 river kilometers are known to be open to American shad passage, while over 810 river kilometers of historical habitat are currently inaccessible (Figure 1, Table 1). Of the habitat that is accessible, a large portion on many rivers is above dams with fishways that may provide only limited accessibility. It is assumed that the

mapped habitat represents both adult and juvenile use. American shad are documented as regular catches in recreational fishing reports from the Sheepscot, Mousam, Presumpscot, Saco and Kennebec rivers and Scarborough Marsh, but there are few reports from other rivers. The population sizes are unknown.

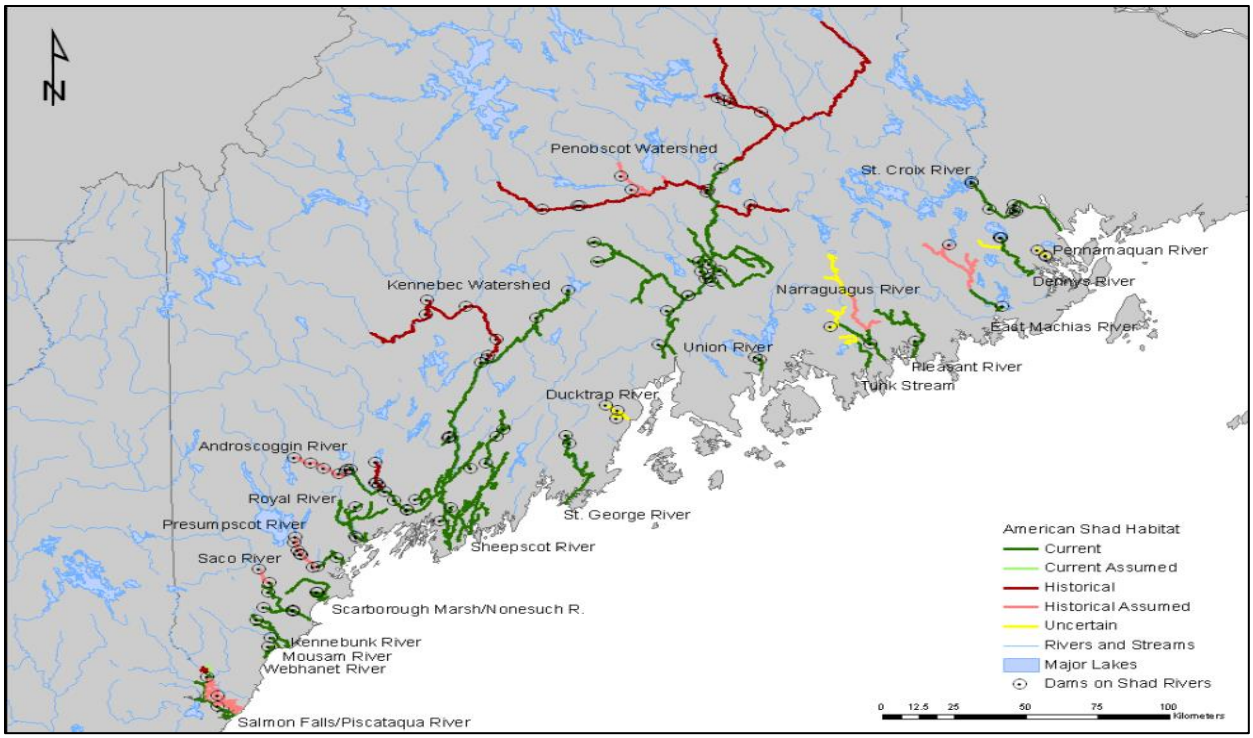

Figure 1. American shad habitat in Maine waters as identified by a USFWS mapping effort (USFWS 1983). Dams and impoundments on shad rivers are also shown.

Major Threats

Barriers to migration are the primary impediments to American shad habitat and successful spawning within Maine state waters. Out of 24 shad rivers in Maine, 18 have a mainstem dam that likely limits shad passage upstream. Of these, five have no capacity for fish passage (Table 2).

Even when fish passage is installed at these dams, the use of habitat upstream of dams is thought to be much lower than the use of areas below the dam. In 2011, video monitoring below Brunswick Fishway on the Androscoggin River documented over 16,000 American shad below the dam, while no shad were passed at the top of vertical slot fishway (J. Lichter, Bowdoin College, pers. comm). Fish passage efficiency for American shad has not been documented at the other sites in Maine, however other studies have described the potential for shad passage.

Table 1. Amount of American shad habitat (river kilometers) in Maine waters (USFWS 1983). Rivers are listed in order of descending habitat kilometers.

River/Watershed	Current (though may be limited)	Current Assumed	Historical	Historical Assumed	Uncertain	Total
Penobscot Watershed	399.6		354.0	32.7		786.3
Kennebec Watershed	300.4		107.2			407.6
Salmon Falls/Piscataqua River	59.8	8.1	8.9	108.1		184.9
Sheepscot River	178.8					178.8
Narraguagus River	38.9			35.6	60.4	134.9
Royal River	106.2					106.2
Androscoggin River	48.3		17.4	34.8		100.5
Saco River	49.1			50.6		99.7
East Machias River	18.8			67.0		85.7
Pleasant River	72.1					72.1
Scarborough Marsh/Nonesuch R.	70.4					70.4
St. George River	65.5					65.5
St. Croix River	61.8					61.8
Kennebunk River	47.0					47.0
Dennys River	34.8				10.7	45.5
Presumpscot River	22.0			22.2		44.2
Tunk Stream	20.2				16.8	37.1
Ducktrap River					22.8	22.8
Webhanet River	8.9					8.9
Union River	7.9					7.9
Pennamaquan River					7.6	7.6
Mousam River	6.3					6.3
Little River	5.5					5.5
Grand Total	**1622.3**	**8.1**	**487.5**	**351.0**	**118.2**	**2587.2**

The majority of the dams with fish passage on shad rivers in Maine have Denil fishways. Denil fishways seem to have high potential for passage (Slatick and Basham 1985, Haro *et al.* 1999), however, the ability of shad to locate the fishway opening in a large mainstem dam may be low, especially when there is a large spillway. Thus, the potential for shad passage above a mainstem dam with a Denil fishway is generally moderate.

Other mainstem dams in Maine have fish lifts. The potential for these locations to pass American shad is thought to be low to moderate. As discussed above, the ability of shad to locate the fish lift entrance is likely hindered by attraction flows from large spillways. Further, in all Maine dams with fish lifts there is evidence that shad remain in holding areas above the fish lift but do not exit the headpond, as evidenced by a large proportion of "passed" shad found only when the facilities are periodically de-watered, and only few shad passed during normal operations (Maine DMR ASMFC Compliance 2011 Report).

Table 2. The first mainstem dams on American shad rivers in Maine with fish passage and dam ownership information listed.

River/Watershed	Distance to first mainstem dam (km)	First Mainstem Dam Name	Fish Passage Type	Shad Passage Potential	Dam Ownership	FERC License	FERC License Renewal
Salmon Falls/ Piscataqua River	26.8	South Berwick Dam	Denil	Moderate	Consolidated Hydro New Hampshire, Inc	Yes	11/30/2037
Salmon Falls/ Piscataqua River	26.6	Great Works Pond Dam	None	None	Great Works Hyrdo Co.	No	
Webhanet River	None						
Little River	3.3	Skinners Mill Dam	None	None	Not listed	No	
Mousam River	6.8	Kessler Dam	None	None	Kennebunk Light and Power District	Yes (3 dams)	3/31/22
Kennebunk River	27.9	Days Mill	None	None	Private	No	
Saco River	9.3	Cataract Project	Fish Lift, Denil, 2 fish locks	Low to Moderate	Brookfield Renewable Energy	Yes (4 dams)	11/30/29
Scarborough Marsh/ Nonesuch R.	None						
Presumpscot River	12.6	Cumberland Mills	Denil Fishway	Moderate	S. D. Warren	No	
Royal River	4.9	Bridge Street Dam	Denil Fishway	Low	Town of Falmouth	No	
Androscoggin River	48.2	Brunswick Project	Vertical slot	Low (Documented)	Brookfield Renewable Energy	Yes	2/28/29
Kennebec River	140.8	Lockwood Project	Fish Lift	Low	Brookfield Renewable Energy	Yes	10/31/36
Sebasticook River	173.6	Benton Falls	Fish Lift	Moderate	Essex Hydro Associates	Yes	2/28/34
Sheepscot River	44.0	Head Tide Dam	Slots	Moderate	Town of Alna	No	
St. George River	48.3	Sennebec Pond Dam	Rock Ramp	High	Sennebec Lake Assoc.	No	
Ducktrap River	17.9	Dickey Mill Dam	None	None	Not listed	No	
Penobscot Watershed	68.5	Milford Dam	Fish Lift	Low to Moderate	Bangor Hydro Electric Co.	Yes	4/1/38
Union River	7.3	Ellsworth Dam	Denil,Trap and Truck	Not Passed Upstream	Black Bear Hydro	Yes	12/31/18 (consulting)
Tunk Stream	None						
Narraguagus River	10.6	Cherryfield Dam	Denil Fishway	Moderate	Town of Cherryfield	No	
Pleasant River	None						
East Machias River	None						
Dennys River	None						
Pennamaquan River	2.9	Pembroke Cottage Dam	Denil Fishway	Moderate	Private	No	
St. Croix River	30.8	Milltown Power Station Dam	Denil Fishway	Moderate	New Brunswick Electric Co.	No	

Water quality. While poor water quality due to point source pollution from tanneries, paper mill companies, and other manufacturing may have negatively impacted adult spawners, developing embryos, and young-of-year in the early to mid-twentieth century, improvements were made as a result of the Clean Water Act after 1970. As a result, it is not thought that poor water quality remains a threat in most known spawning/rearing locations. Basic water quality parameters (temperature, dissolved oxygen, turbidity, pH) are well above the tolerances for American shad, when they are taken. It should be noted that only temperature is taken on a daily basis at most fishways in Maine whether DMR or power-company operated. Moreover, there are no current studies in Maine to determine whether existing levels of toxic contaminants (heavy metals, PCBs) may be negatively affecting shad populations.

The Maine Department of Environmental Protection (DEP) administers regular water quality testing of Maine's waters. The State has four classes for freshwater rivers, three classes for

marine and estuarine waters, and one class for lakes and ponds. A close comparison of the standards will show that there are few differences between the uses or the qualities of the various classes. All classifications attain the minimum fishable-swimmable standards established in the federal Clean Water Act, and most support the same set of designated uses with some modest variations in their description. More information about the classification schema can be found at: http://www.maine.gov/dep/water/monitoring/classification/

The Maine DEP determines the water quality classification of freshwater areas through the Biological Monitoring Program. This program assesses the health of rivers, streams, and wetlands by evaluating the composition of resident aquatic benthic macroinvertebrate and algal communities. The DEP develops standards for each river, stream and wetland using these methods, testing important sites on a rotating basis. Smaller waterways may be tested infrequently. More information can be found at: http://www.maine.gov/dep/water/monitoring/biomonitoring/index.html

Marine water quality is assessed by multiple organizations and the information compiled by the Maine DEP for Clean Water Act reports that are due every other year to the EPA. The DEP utilizes data for assessments in marine waters from its own environmental and toxics monitoring programs including the Surface Water Ambient Toxics and the Gulf of Maine Council on the Marine Environment's Gulfwatch project, and to a large extent from a variety of governmental agencies, academic institutions, non-profit organizations and municipalities, such as the Maine Healthy Beaches program, Maine Department of Marine Resources, New Hampshire Department of Environmental Services, University of Maine, BioDiversity Research Institute, Casco Bay Estuary Partnership, Kennebec Estuary Land Trust, Marine Environmental Research Institute, Mount Desert Island Biological Laboratory, Town of Rockport Conservation Commission, and the Wells National Estuarine Research Reserve. Additionally, a number of volunteer monitoring groups monitor Maine's estuarine and coastal waters. The DEP currently accepts data from organizations with approved Quality Assurance Project Plans (QAPPs) whose monitoring programs and analytical labs enable collection and processing of quality data, and from selected organization with DEP-approved sampling plans. Biannual reports can be found at: http://www.maine.gov/dep/water/monitoring/305b/index.htm

Channelization and dredging. occur in Maine waters, though are not thought to be a significant threat to American shad habitat. Channelization and dredging typically occur beyond the mouths of rivers in association with beach restoration (southern Maine) or shipping lanes (Kennebec River, Bath Iron Works). Before any channelization or dredging project commences, it must first be reviewed by all relevant agencies (including Maine DMR, Maine DEP, USFWS, and NOAA) which provide comments concerning species interaction.

Invasive species. Concerning the threat from competition and predation, a growing number of invasive white catfish, carp (*Cyprinus carpio*), and Northern pike have been documented in Maine. These species are found in American shad spawning areas, but the impact on shad populations has not been documented.

Statewide Available Data

In 1982, the US Fish and Wildlife Service (USFWS) compiled habitat information for many diadromous species to create a snapshot of the current and historic distribution in Maine that is available from the USFWS Northeast Regional Office's data website (USFWS 2013). The purpose of this project was to identify, based on the best available information, the current and historic geographic distribution of 12 diadromous (sea-run) fish species in Maine (alewife, American eel, American shad, Atlantic salmon, Atlantic sturgeon, Atlantic tomcod, blueback herring, rainbow smelt, sea lamprey, sea run brook trout, shortnose sturgeon, striped bass).

To begin this process, available digital data depicting current and historic extent of each species was presented on a series of paper maps. These maps were distributed throughout the state and reviewed by fisheries biologists, including representatives from government agencies, non-government organizations and private individuals. Reviewers edited the maps on the basis of their personal knowledge, institutional knowledge and review of existing data and documents, both published and unpublished. These maps were then collated and coded in a networked hydrography dataset (the most detailed available National Hydrography Dataset[NHD]) resulting in one GIS layer (a line Feature Class) for each fish species. Each Feature Class shows the user the current and historic extent of the species and the sources used to delineate that extent. The Feature Class can be used alone but is most useful when joined back to the NHD as an event table, thus making additional data available (e.g. feature names, flow, etc.). The 'AmericanShad' feature class specifically identifies the current and historic distribution of American shad in Maine (USFWS 1982).

Agencies with Regulatory Authority

Maine DMR, USFWS, NOAA, Maine DEP, FERC

Other Organizations

Dam ownership for first mainstem dams is listed in Table 2.

Current Action and Progress

During all Federal Energy Regulatory Commission (FERC) relicensing processes, the Maine DMR in collaboration with federal agencies advocates for fish passage that will allow the best accommodation for all diadromous fish passage, including American shad passage. In addition to FERC processes, the Maine DMR also provides comments on most fish passage projects in the state – where there is a project on identified shad river, we provide comments and work with public and private landowners to install fish passage, or upgrade existing passage, to allow for all maximum passage potential for all diadromous species, including American shad.

Regarding monitoring projects, other than three on-going activities (fishway monitoring on the major rivers, juvenile beach seine and in-river trawl surveys, recreational fishing surveys), there are few efforts focused on American shad in Maine waters. There are a few river-specific projects that are discussed in the sections below, including video monitoring at Brunswick fishway. There are, however, no efforts to ground-truth the assumed current spawning habitat, and currently no fishway efficiency studies that focus on shad passage.

Larval stocking. American shad fry were raised at the Waldoboro hatchery from 1992 to 2008 using eggs collected from adults from the Kennebec, Connecticut, Androscoggin, Merrimack, Saco, and Sebasticook Rivers. The program ended in 2008 due to a lack of funding. Larval American shad that were reared in the hatchery were 'marked' by immersion in an oxytetracycline (OTC) bath before being released. Receiving locations included multiple sites on the Androscoggin, Kennebec, and Sebasticook Rivers (both below and above dams), as well as at the presumed spawning locations on the Medomak River and on the Saco River in tidal water. The hatchery closed in 2009 with no plans to reopen the hatchery due to funding and current management of American shad along the East Coast.

Adult American shad otoliths are collected from mortalities at fish passage facilities, from juveniles collected during the beach seine surveys, and from some anglers who voluntarily submitted samples. The Maine DMR inshore trawl survey also began collecting otoliths from a sub-sample of American shad in fall 2012. Difficulty with fine tuning OTC marking processes due to hard water, excessive mortality while applying more than one mark and reading OTC presence on recovered otoliths complicated assessing returns from the project. While we have not directly measured the success of the stocking program, juvenile abundance in the Kennebec/Androscoggin complex does seem to have increased concurrent to larval stocking

Juvenile Abundance Surveys. In 1979, MDMR established the Juvenile Alosine Survey for the Kennebec/Androscoggin estuary to monitor the abundance of juvenile alosines at 14 permanent sampling sites. Four sites are on the upper Kennebec River, three on the Androscoggin River, four on Merrymeeting Bay, one each on the Cathance, Abagadasset, and Eastern rivers. These sites are in the tidal freshwater portion of the estuary. Since 1994, Maine DMR added six additional sites in the lower salinity-stratified portion of the Kennebec River.

Over the entire sampling period (1979-2019), the overall highest average catch per unit effort (CPUE) for juvenile American shad was found in the Abagadasset River (9.82 shad per haul), followed by the upper Kennebec River (8.70). Merrymeeting Bay (5.92), the Cathance (3.83), Eastern (3.36), and the lower Kennebec rivers (3.22) all have lower but consistent CPUE values. The Androscoggin River has consistently low catches of shad or years where no shad are caught (0.44 shad per haul; Table 3). The strength of these data in identifying successful spawning areas is limited because sampling in performed after the spawning event, and juvenile shad may have dispersed from their natal location by passive larval drift. These data may provide some insight into juvenile shad habitat.

Recommended Action(s)

- Remove mainstem hydropower dams or install effective fish passage
- Ground-truth assumed current spawning habitat state-wide
- Conduct population estimates for Saco, Androscoggin, Kennebec/Sebasticook, and Penobscot rivers
- Map young-of-year habitat based on existing beach seine and in-river trawl surveys in the Kennebec River/Merrymeeting Bay estuary complex and Penobscot River
- Conduct fishway efficiency studies that focus on shad passage at existing fishways
- Determine locations beyond those regularly monitored where American shad passage may be limited by human-made obstructions

Table 3. American shad catch per unit effort in eight survey locations in the Kennebec River/ Merrymeeting Bay estuary complex. Survey design was altered in 1994 when 6 stations were added to the survey sites.

Juvenile American Shad Catch per Unit Effort by River Segment								
Year	Upper Kennebec River	Merrymeeting Bay	Androscoggin River	Cathance River	Abagadasset River	Eastern River	Mid Kennebec River	Lower Kennebec River
1979	0.16	0.00	0.00	0.00		0.00		0.00
1980	0.00	0.36	0.29	0.00		0.00		0.00
1981	1.08	0.85	0.29	0.50		0.00	0.17	0.00
1982	0.00	0.33	0.17	0.00		0.00	0.63	0.00
1983	0.15	0.20	2.18	3.00		0.00		
1984	0.90	0.46	0.00	2.00		0.67		
1985	0.69	1.53	0.40	6.50		7.00		
1986	0.10	0.15	0.08	1.00		0.50		
1987	0.15	8.05	0.17	1.25	0.50	0.00		
1988	0.11	1.36	0.00	0.00	0.33	0.51		
1989	1.25	0.29	1.29	0.48	0.00	0.00		
1990	3.50	2.46	0.83	6.83	0.33	4.20		
1991	1.21	0.00	0.00	0.67	1.67	1.17		
1992	0.10	0.67	0.67	3.67	0.00	0.00		
1993	0.00	0.29	3.63	0.00	0.00	0.00		
1994	0.00	0.35	1.00	0.00	0.17	0.50		
1995	0.21	0.39	1.89	0.17	0.60	0.33		
1996	4.15	0.25	0.00	0.20	0.33	0.50		
1997	0.00	0.88	0.80	0.00	0.40	0.00		
1998	0.00	1.67	0.00	0.00	0.00	0.00		
1999	0.00	20.46	0.00	42.67	33.00	0.00		
2000	15.14	0.33	0.14	0.33	0.33	1.33		1.58
2001	0.57	3.14	2.57	0.43	0.00	0.20		0.05
2002	1.96	2.18	0.18	1.86	22.86	2.43		0.19
2003	74.13	3.63	0.00	2.17	0.67	5.33		0.42
2004	48.21	6.67	0.00	0.67	3.00	0.50		0.39
2005	24.96	3.42	0.06	2.83	10.00	2.40		3.72
2006	38.79	25.30	0.00	0.67	16.50	8.33		5.44
2007	33.38	24.13	0.00	0.67	19.00	16.83		1.40
2008	3.95	12.88	0.00	3.00	34.17	3.67		1.38
2009	4.29	16.38	0.20	4.17	31.67	5.17		1.27
2010	45.63	8.25	0.39	11.00	15.33	7.17		1.03
2011	0.63	11.25	0.00	25.33	94.17	9.17		1.73
2012	1.30	11.17	0.06	8.00	13.00	19.67		16.86
2013	5.75	27.83	0.00	3.17	17.83	3.17		32.72
2014	11.08	14.83	0.00	3.17	54.00	3.50		8.69
2015	9.67	3.59	0.53	1.17	21.00	3.83		0.56
2016	4.25	3.13	0.00	7.17	0.83	5.83		0.67
2017	12.0	13.55	0.00	5.20	3.40	8.16		1.43
2018	1.79	5.21	0.28	0.83	1.33	9.0		0.22
2019	5.33	4.79	0.00	6.33	6.19	6.83		0.69
Average	8.70	5.92	0.44	3.83	9.82	3.36	0.40	3.22

Saco River

Amount of Habitat

There are currently 49.1 river kilometers of accessible shad habitat in the Saco River (though accessibility to habitat above dams with fish passage is limited), with another 50.6 river kilometers of assumed historical habitat (Table 1). Spawning and juvenile habitat have not been identified. Although no studies have documented shad spawning areas in the Saco River, it is thought that the majority of spawning occurs below the Cataract Project mainstem dams. Habitat above this area is mapped as accessible habitat because shad passage is possible at the Skelton Dam fish lift and interim trap and truck operations to move shad past the project's fish locks (see discussion below). The river portion listed as inaccessible (historical assumed) is above the Bar Mills, which currently has no fish passage facility (Figure 3).

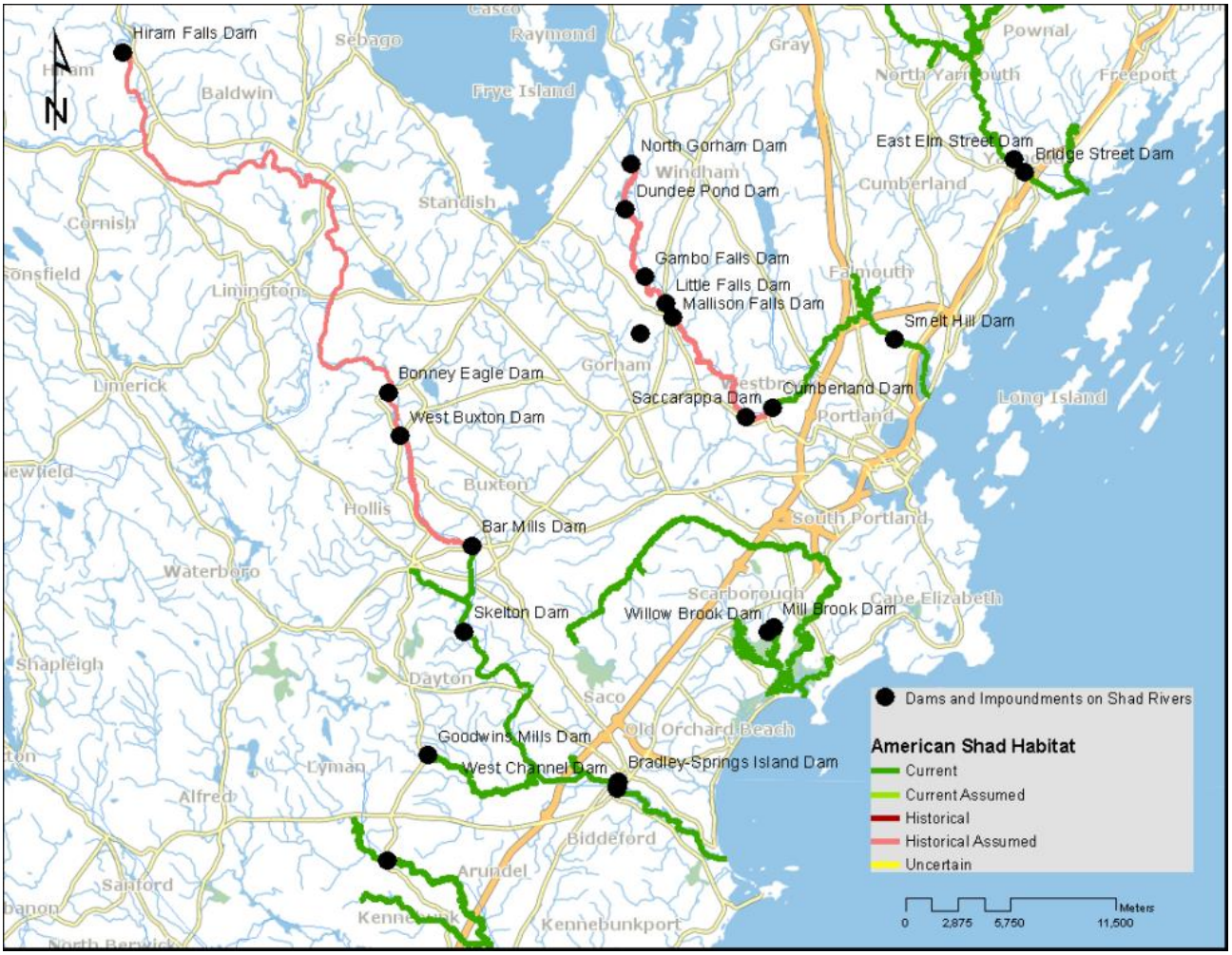

Figure 3. Saco River American shad habitat. Historical habitat is above dams with no fish passage. The Scarborough Marsh and Nonesuch River shad habitat is also shown in full in the middle-right of the figure.

Available Data

- Adult American shad counts, Brookfield Renewable Energy
- Video monitoring of shad behavior downstream on the Cataract Project, Brookfield Renewable Energy
- Maine DEP water quality reports
- USFWS. 1983. American Shad Habitat in the Gulf of Maine. http://www.fws.gov/r5gomp/gom/habitatstudy/metadata/shadhab83.htm
- USFWS. 2013. GIS Data at the Gulf of Maine Coastal Program. http://www.fws.gov/r5gomp/gisindex.htm

Threat(s)

- Barriers to migration

The majority of shad passage on the Saco River occurs at the East Channel fish lift of the Cataract Project. The project is licensed by the Federal Energy Regulatory Commission (FERC No. 2528) and is owned by Brookfield Renewable Energy (formerly NextEra, formerly Florida Power and Light). The project includes the Cataract (East Channel) Dam and East Channel fish lift and an integral intake powerhouse containing a single turbine generator on the northeastern side of Factory Island in the City of Saco; and the West Channel dam and Denil fishway in the cities of Saco and Biddeford (Figure 3).

The impoundment formed by these dams extends upriver in the cities of Biddeford and Saco about 0.3 mile to another set of dams at Spring Island referred to as Bradbury and Spring Island dams. The impoundment formed by these dams extends upriver approximately 9.3 miles through the cities of Biddeford and Saco and the towns of Dayton and Buxton to Brookfield Renewable Energy's Skelton Project (Figure 3). A 90-foot high fish lift was constructed at the Skelton Project and first became operational in the fall of 2001.

Agencies with Regulatory Authority

Maine DMR, USFWS, NOAA, Maine DEP, Brookfield Renewable Energy (formerly NextEra, formerly Florida Power and Light)

Other Organizations

Saco River Salmon Club

Current Action and Progress

Monitoring and Passage. In 2019, the Cataract fishways were operated by personnel from Brookfield Hydro Operations division. These fishways were built to pass anadromous target species (Atlantic salmon, American shad, and river herring) as part of resource agency plans to restore these species to the Saco River, and have operated for 26 years. Although fishway construction was completed in the spring of 1993, the fishways were not completely operational until June 2, 1993 (East Channel) and June 25, 1993 (West Channel).

An underwater camera connected to a television monitor and VCR was first used in 1995 to gather information on fish behavior within the lower flume of the East Channel fish lift. The camera documented that shad exhibit a fallback behavior in and around the East Channel lower

flume V gate crowder. On occasion, shad would swim upstream through the V gate crowder into the hopper area, then within minutes (and sometimes seconds) swim back downstream through the V gates and out of the lower flume into the tailrace. Also, on many occasions, shad were reluctant to pass through the V gate crowder in the fishing position (see 1995 Cataract fishway study report Sections 3 and 4 for detailed information on camera study and results). Since 1996, the underwater video camera, combined with keeping the V gate crowder wide open, was a very important technique that increased East Channel fishway efficiency. Fishway personnel observed that by keeping the V gate crowder open, shad moved readily into the trapping area. Utilizing the underwater camera, fishway personnel could observe shad as they passed through the wide open V gate crowder, then close the crowder and trap before the shad had a chance to fall back. This technique will continue in 2020.

A 2007 settlement agreement provides a schedule for fish passage at the remaining dams owned by FPL Energy (Table 4), a schedule for effectiveness testing, and a schedule for improvements at the Spring Island or Bradbury dam so American shad can pass.

Table 4. Schedule for fish passage implementation at Saco River dams.

Dam Name	Upstream anadromous passage
Cataract - East Channel, West Channel	fish lift, Denil
Cataract - Springs Island, Bradbury	fishlocks
Skelton	fish lift
Bar Mills	5/1/2016
West Buxton	5/1/2019
Bonny Eagle	5/1/2022
Hiram	5/1/2025

In 2019, Brookfield Energy biologists counted a total of 1,139 American shad (1,121 passing the East Channel Dam, and 18 passing the West Channel Dam, Figure 4). Of the 1,121 American shad passed through the Cataract East Channel fishway, a total of 64 shad mortalities were noted. This represents a total fishway mortality of 5.6 %, which is slightly higher compared to past years: 1995 (3.5%), 1996 (4.8%), 1997 (2.7%), 1998 (3.5%), 1999 (2.6%), 2000 (2.7%), 2001 (2.4%), 2002 (2.8%), 2003 (2.5%), 2004 (3.0%), 2005 (2.6%), 2006 (2.8%), 2007 (3.0%), 2008 (2.9%), 2009 (4.8%), 2010(1.9%), 2011 (2.1%), 2012 (1.2%), 2013(1.3%) , 2014 (2.2%), 2015(1.8%), (3.2%), 2017 (2.1%), 2018 (1.3) and 2019 (5.6%). The majority of the American shad captured at the East Channel fish lift were transported to the Diamond Riverside Boat Ramp stocking location (approximately half mile upstream of the fishway), while the remaining shad were allowed to freely swim through the fishway into the Cataract impoundment.

At the Skelton Project during the 2012 season, 47 shad were lifted. It is assumed that many of the American shad that were not lifted at the Skelton fishway spawned below the project, as post-spawned American shad and juvenile American shad are routinely observed at the downstream Cataract Project. Also, the 9.3 miles between the Skelton Project and the Cataract Project provides potential spawning habitat for approximately 25,000 adult American shad.

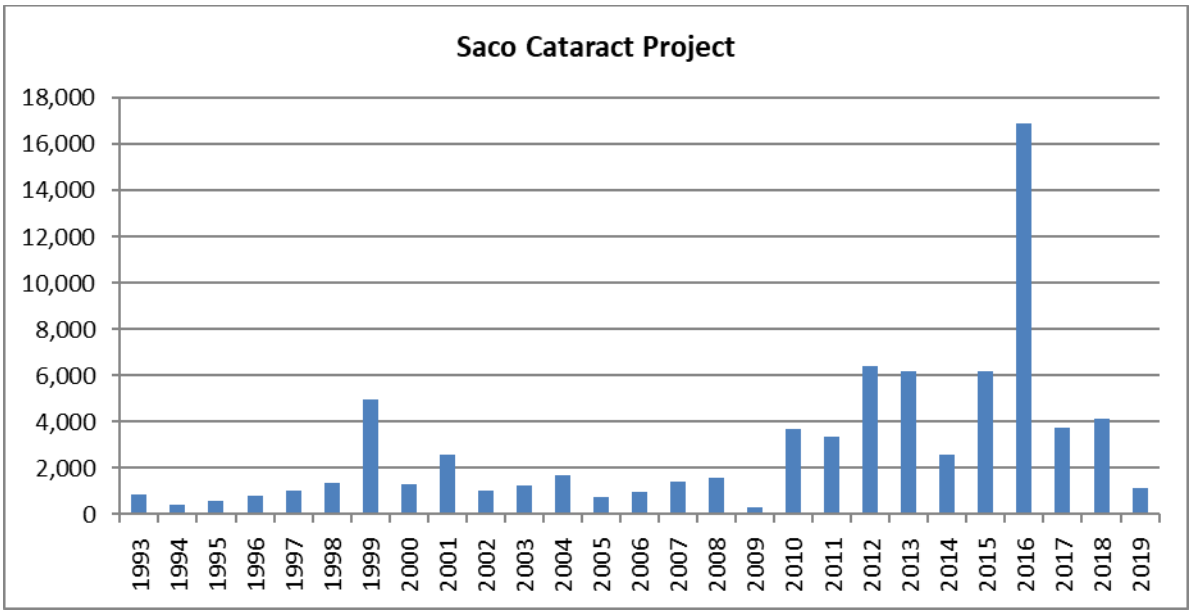

Figure 4. American shad passage at the Cataract Project from 1993 to 2019.

Goals and Recommended Actions

- Continue DMR consultations on proposed operational change to improve shad passage at fish locks
- Ground-truth spawning habitat both below Cataract projects and identify additional spawning habitat upstream
- Estimate mortality for adult shad passing the Cataract Project
- Conduct downstream efficiency and mortality studies
- In addition to video monitoring at the Cataract Project, document upstream efficiency at this location and at the Skelton Project
- Monitor water chemistry (DO, turbidity, pH, temperature, conductivity) during spawning season

The timeline and associated costs of these recommended actions has not been determined.

Androscoggin River

Amount of Habitat

The Androscoggin River contains 100.5 river kilometers of potential American shad habitat. Of this, 48.3 river kilometers are accessible (though accessibility to habitat above dams with fish passage is limited), while the remaining habitat is inaccessible due to obstructed fish passage (Figure 5, Table 1). While passage above the Brunswick Dam is considered possible because the vertical-slot fishway allows some shad passage, actual passage by American shad has been documented to be very low (Figure 6), and the majority of habitat use has been documented in the small portion of river below the dam.

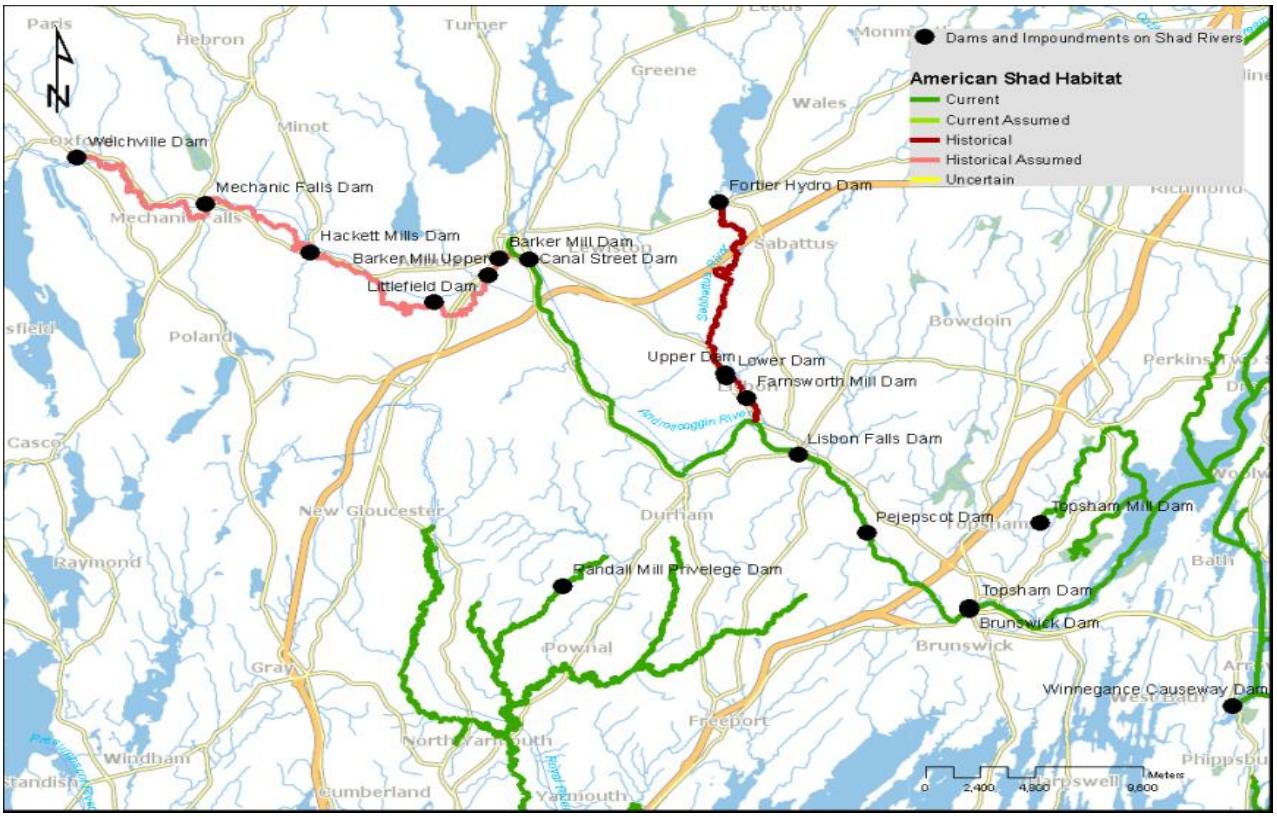

Figure 5. Androscoggin River American shad habitat. Historical habitat is above dams with no fish passage. The upper portion of the Royal River also is shown at the bottom of the figure.

Available Data

- Adult American shad counts, Maine DMR
- Juvenile Abundance, Maine DMR
- Video monitoring of shad behavior downstream of Brunswick Fishway, Bowdoin College
- Maine DEP water quality reports
- USFWS. 1983. American Shad Habitat in the Gulf of Maine. http://www.fws.gov/r5gomp/gom/habitatstudy/metadata/shadhab83.htm
- USFWS. 2013. GIS Data at the Gulf of Maine Coastal Program. http://www.fws.gov/r5gomp/gisindex.htm

Threat(s)

- Barriers to migration
- Past water quality (no longer considered to be a threat)
- Invasive species (possible, not studied)

American shad historically spawned in the Androscoggin River from Merrymeeting Bay to Lewiston Falls, and in the Little Androscoggin River from its confluence with the Androscoggin to Biscoe Falls. However, construction in 1807 a low-head dam at the head-of-tide on the Androscoggin River caused the abundant American shad run to decline sharply.

Barriers to migration. In 1980 the U.S. Fish and Wildlife Service developed conceptual drawings for a vertical slot fishway for the Brunswick Project, which is located at the head-of-tide on the Androscoggin River. The fishway was designed to pass 85,000 American shad and 1,000,000 alewives annually. The upstream passage facility was one of the first vertical slot fishways designed to pass American shad on the east coast, and was a scaled-down version of a fishway located on the Columbia River. Redevelopment of the Brunswick Project and construction of the fishway was completed in 1983. The completed fishway was 570 feet long, and consisted of 42 individual pools with a one-foot drop between each. Downstream passage consisted of a 12-inch pipe located between two turbine intakes. When the Federal Energy Regulatory Commission issued a license for the Brunswick Project in 1979, it did not require efficiency studies for the upstream and downstream passage facilities.

Maine DMR initiated an anadromous fish restoration program in the Androscoggin River after fish passage was installed the Brunswick Project dam, and just prior to the installation of passage in 1987 and 1988 at the next two upstream projects. Between 1985 and 2008, a total of 7,882 prespawn American shad from in-state (Cathance and Androscoggin rivers) and out-of-state (Merrimack and Connecticut rivers) sources were stocked into spawning habitat below Lewiston Falls. In addition, approximately 5.6 million shad fry were stocked into these waters between 1999 and 2008.

Currently the factor limiting successful American shad restoration to the Androscoggin is the lack of effective passage at the Brunswick Project. Neither the Brunswick vertical slot fishway nor a similar one at the Rainbow Dam on the Farmington River, CT, has proven to be successful at passing American shad. Visual observations, underwater videography, and radio telemetry studies conducted at the Brunswick Project by Maine DMR in cooperation with the U.S. Fish and Wildlife Service have shown that American shad swim past the fishway entrance repeatedly, but rarely enter it. The few shad that enter the fishway rarely ascend beyond the corner pool, and in 37 years of operation only 1,553 American shad have used the fishway.

In February 2011, NextEra Energy, owner of the Brunswick Project, agreed to conduct an experiment to determine whether upstream passage of American shad could be improved by increasing the amount of attraction water at the fishway (see Video Monitoring below).

Past water quality. After dams confined American shad to the tidal portion of the river, severe water pollution virtually eliminated the population. American shad that continued to reproduce in the six-mile stretch of river below Brunswick supported significant commercial fisheries until the

late 1920's. By the early 1930s, severe water pollution from upstream industries and municipalities had caused declines in many fish species. Water pollution abatement efforts that began in the early 1970s resulted in the dramatic improvement of water quality in the Androscoggin River.

Invasive species. White catfish, carp (*Cyprinus carpio*), and Northern pike populations are known to be increasing in the lower Androscoggin River, in the portion where American shad spawning occurs and where juvenile shad are found. The effect of these invasive species on shad populations is not known, however white catfish are known to eat fish eggs of native species.

Agencies with Regulatory Authority

Maine DMR, USFWS, NOAA, Maine DEP, Brookfield Renewable Energy (formerly NextEra, formerly Florida Power and Light)

Other Organizations

Bowdoin College, University of Maine, Bates College, University of Southern Maine, Androscoggin River Alliance, Friends of Merrymeeting Bay

Current Action and Progress

Juvenile Abundance Surveys. See description in State-Wide Information above.

Monitoring and Passage. Fisheries personnel monitor American shad during their spawning migration at the Brunswick Fishway on the Androscoggin River. Shad are counted and passed upstream as they are encountered at the top of the fishway, after the shad have volitionally passed the 42 pools of the fishway. Biological sampling (length, weight, sex, and scale sample) is not performed on live American shad because the run levels continue to be extremely low, and any handling may cause mortality. Sampling is performed on American shad that have experienced fish passage mortality. Passage of American shad has remained low – only 11 were passed in 2012, and only 289 total passed in all years of the data series (Figure 6).

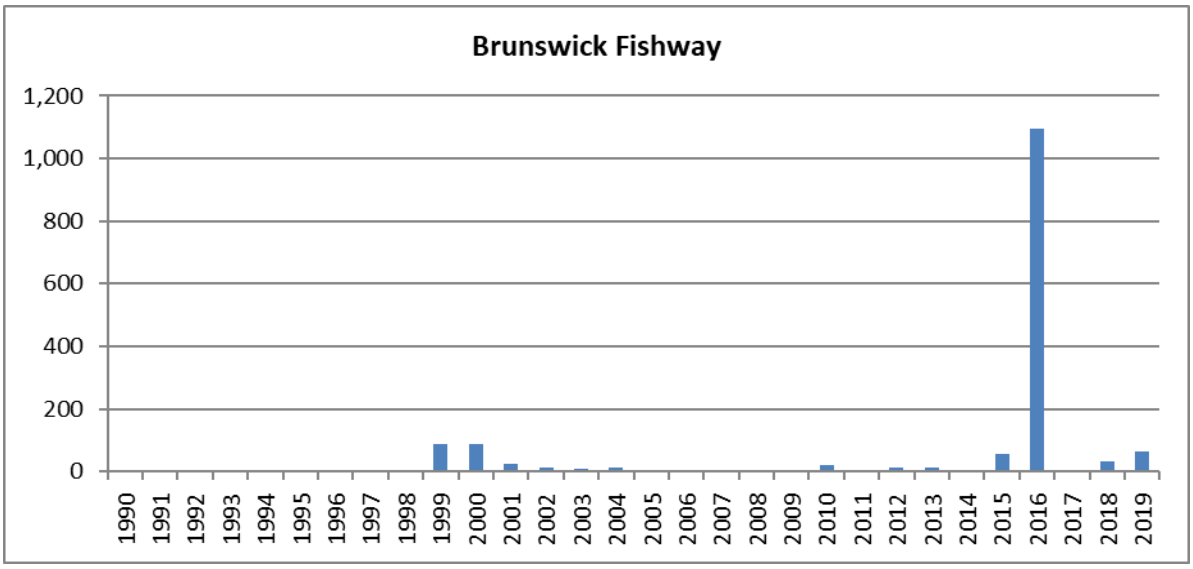

Figure 6. American shad passed above the Brunswick fishway from 1990 to 2019.

Video monitoring. In 2011 and again in 2013, John Lichter of Bowdoin-Bates-USM research group along with his summer research students, Bob Richter of Brookfield Renewable Power, Neil Ward of the Androscoggin River Alliance, and Gail Wippelhauser of the Maine DMR collaborated on an experiment to determine whether upstream passage of spawning American shad at Brunswick Fishway could be improved by increasing the attraction flow at the fishway entrance. Two current inducers were installed adjacent to the fishway entrance. The presence and behavior of American shad was monitored with two underwater cameras, one located in the river about 40 m feet downstream of the fishway entrance to confirm the presence of shad in the river, and a second one placed adjacent to the fishway entrance. Digital video recorders, computers, and software were installed in the fish ladder control room. Salmonsoft@ software was used to record video images when a fish crossed in front of each of the cameras.

In 2011, inducers were turned on and off over alternating two-hour periods. Approximately 16,558 American shad were counted at the lower camera, although previous telemetry studies have shown that an individual may swim past this part of the river multiple times per day. The fish were active primarily during the day for a period of 5-6 h, beginning 1-2 hours before high slack water and continuing for 3-4 hours into the ebb tide. A total of 91 American shad were seen at the entrance of the fishway. More fish were seen at the entrance in the afternoon than in the morning, and more fish were seen when the current inducers were turned on (54) than when the inducers were off (37). However, the current inducers were more effective in the morning than in the afternoon. In 2013, two current inducers were installed adjacent to the fishway entrance and were alternately turned off for 24 hours (attraction water of 100 cfs) then on for 24 hours (attraction water of 180 cfs) with the change occurring at noon every day. Approximately 500 of the nearly 25,000 shad viewed at the lower camera made it to the entrance of the fish ladder. To date, we have only completed roughly 2/3rds of the 2013 video data analysis. Equipment damage related to flooding prevented the study in 2012.

Because it is not clear how many of the 16,000-25,000+ shad viewed at the lower camera circled around the far side of the river after failing to find the fish ladder and were subsequently recounted in the lower camera, we conducted a study to determine shad movement patterns in the tailrace of the dam in 2014. There appears to be some number of thousands of shad trying to navigate past the Brunswick Hydroelectric facility each year. Previous work with Michael Brown of the Maine DMR and John Lichter, Bowdoin College, showed that shad will spawn in the tidal waters of the lower Androscoggin if they cannot pass the dam.

Goals and Recommended Actions

- Conduct population estimates for adults spawning in the lower Androscoggin River
- Map young-of-year habitat based on existing beach seine surveys
- Continue fishway efficiency studies at Brunswick Fishway that document poor passage by adult American shad
- Monitor water chemistry (DO, turbidity, pH, temperature, conductivity) during spawning season
- Study impact of invasive species populations on shad populations

The timeline and associated costs of these recommended actions has not been determined.

Kennebec and Sebasticook Rivers

Amount of Habitat

The Kennebec watershed contains 407.6 river kilometers of potential American shad habitat. Of this, 300.4 river kilometers are currently accessible (though accessibility to habitat above dams with fish passage is limited), while the remaining 107.2 river kilometers are inaccessible due to obstructed fish passage (Table 1).

The watershed contains two major spawning areas, the mainstem Kennebec River below Lockwood Dam and the Sebasticook River below Benton Falls Dam (Figure 7). While passage above these is considered possible because both dams have fish lifts, actual passage by American shad has been documented to be very low (Figure 8), and the majority of spawning is thought to occur below the first mainstem dams.

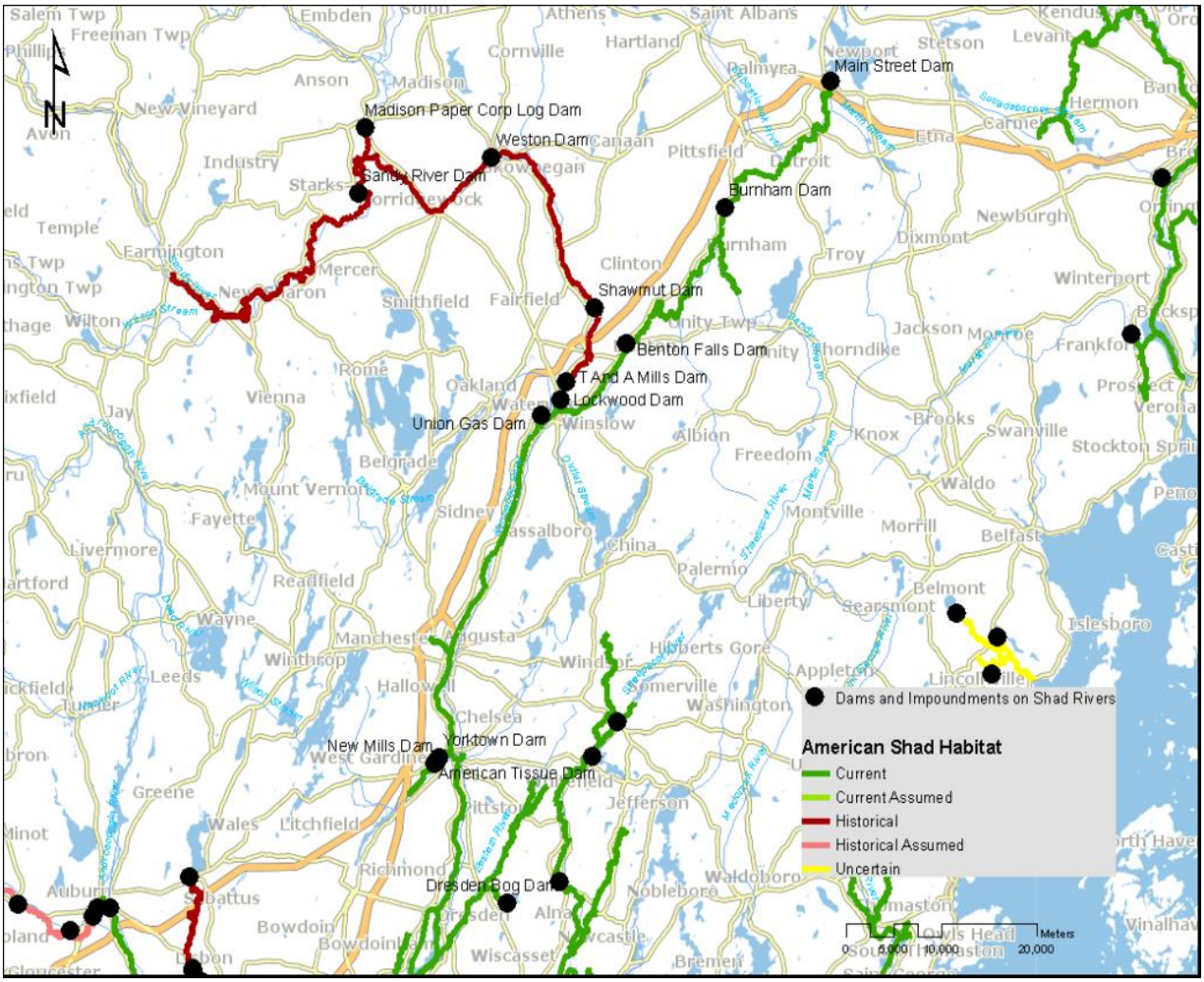

Figure 7. American shad habitat in the Kennebec and Sebasticook rivers. Historical habitat is above dams with no fish passage. The upper portion of the Sheepscot River also is shown at the bottom of the figure, in close proximity to the lower Kennebec River.

Available Data

- Adult American shad counts, Maine DMR
- Juvenile Abundance, Maine DMR
- Maine DEP water quality reports
- USFWS. 1983. American Shad Habitat in the Gulf of Maine. http://www.fws.gov/r5gomp/gom/habitatstudy/metadata/shadhab83.htm
- USFWS. 2013. GIS Data at the Gulf of Maine Coastal Program. http://www.fws.gov/r5gomp/gisindex.htm

Threat(s)

- Barriers to migration
- Past water quality (no longer considered to be a threat)
- Invasive species (possible, not studied)

Barriers to migration. The Kennebec River Restoration Program was initiated following the development of a Strategic Plan in 1985, an Operational Plan in 1986, and the signing of an Agreement in 1986 between the Maine DMR and the Kennebec Hydro Developers Group (KHDG). This Agreement provided a delay in fish passage requirements at seven hydropower facilities above Augusta in exchange for funds to initiate the restoration by means of trap-and-truck of river herring and American shad to selected upriver spawning and nursery habitat. In 1998, a new Agreement between state and federal fisheries agencies and the members of the KHDG was signed. The new Agreement provided for the removal of Edwards Dam, included new timetables or triggers for fish passage at the seven hydropower facilities above Augusta, and provided additional funds to continue the restoration by trap-and-truck. In 2006, the Kennebec River Restoration Program entered a new phase when upstream anadromous fish passage became operational at the Benton Falls, Burnham, and Lockwood hydropower projects (Figure 7).

Upstream passage at the Burnham and Benton Falls was required to be operational one year following the installation of permanent or temporary upstream fish passage at Fort Halifax and following installation of permanent upstream fish passage at four upriver non-hydro dams. These projects included the implementation of interim upstream passage measures at Fort Halifax dam and the construction of fishways at the Pleasant Pond dam in Stetson, the Plymouth Pond dam in Plymouth, the Sebasticook Lake outlet dam in Newport and the removal of the Guilford dam in Newport. Passage at the Benton Falls Dam was established in 2006 by way of a fish lift. The top of the lift contains a watered holding area leading to a large fish excluder, a gate with vertical bars spaces 2" apart to prevent larger fish from passing in an effort to minimize invasive species passage. All American shad passing Benton Falls must be manually passed upstream over this excluder grate. A fish lift also provides passage at the Burham Dam, however no upstream excluder panel prevents free passage of shad once they pass the fish lift.

The Lower Kennebec River Comprehensive Hydropower Settlement Accord requires that the Licensee install a trap, lift, and transfer facility at the project's powerhouses at Lockwood Dam. These facilities were operational in 2006. American shad that reach the top of the fish lift are passed upstream, however the next dam 1.9 river kilometers upstream has no fish passage capabilities.

The potential for these locations to pass American shad is thought to be low to moderate. The ability of shad to locate the fish lift entrance is likely hindered by attraction flows from large spillways. Further, at Benton Falls Dam there is evidence that shad remain in holding areas undetected, as evidenced by a large proportion of "passed" shad found only when the facilities are periodically de-watered, and only few shad passed during normal operations (Maine DMR ASMFC Compliance 2011 Report). However, this effect may be a result of flow differentials between the downstream portion of the dam and the headpond. Shad may remain in the portion between the fish lift and the headpond for longer periods of time because the flow is much lower than the tailraces, and use this time for resting.

Past water quality. Water pollution from upstream industries and municipalities in the early to mid-20th century had significant impacts on water quality in the Kennebec watershed and was thought to cause declines in many fish species populations. Water pollution abatement efforts that began in the early 1970s resulted in the dramatic improvement of water quality in the Kennebec and Sebasticook rivers. While water quality has drastically improved over the past forty years, high levels of PCBs and some toxic contaminants are still found in many resident fish species.

Invasive species. White catfish and carp (*Cyprinus carpio*) populations are known to be increasing in the Kennebec and Sebasticook rivers, in the portion where American shad spawning occurs and where juvenile shad are found. The effect of these invasive species on shad populations is not known, however white catfish are known to eat fish eggs of native species.

Agencies with Regulatory Authority

Maine DMR, USFWS, NOAA, Maine DEP, Brookfield Renewable Energy (formerly NextEra, formerly Florida Power and Light), KEI (USA) Power Management Inc., Benton Falls Associates (Essex Hydro Associates), Kennebec Hydro Developers Group

Other Organizations

Friends of Merrymeeting Bay, Kennebec Estuary Land Trust, Sportsman's Alliance of Maine

Current Action and Progress

Juvenile Abundance Surveys. See description in State-Wide Information above.

Monitoring and Passage. Fisheries personnel monitor American shad during their spawning migration at the Lockwood Dam on the Kennebec River and the Benton Falls Dam on the Sebasticook River. Shad are counted and passed upstream as they are encountered at the top of the fishway, after the shad have volitionally entered the fish lift. Biological sampling (length, weight, sex, and scale sample) is not performed on live American shad because the run levels continue to be extremely low, and any handling may cause mortality. Sampling is performed on American shad that have experienced fish passage mortality. Passage of American shad has remained low – only 44 were passed in 2019 at the Lockwood Dam, and only 1,625 total since the fish lift at Lockwood was operational. Passage at Benton Falls Dam remains low: in 2019, 114 shad passed upstream (Figure 8).

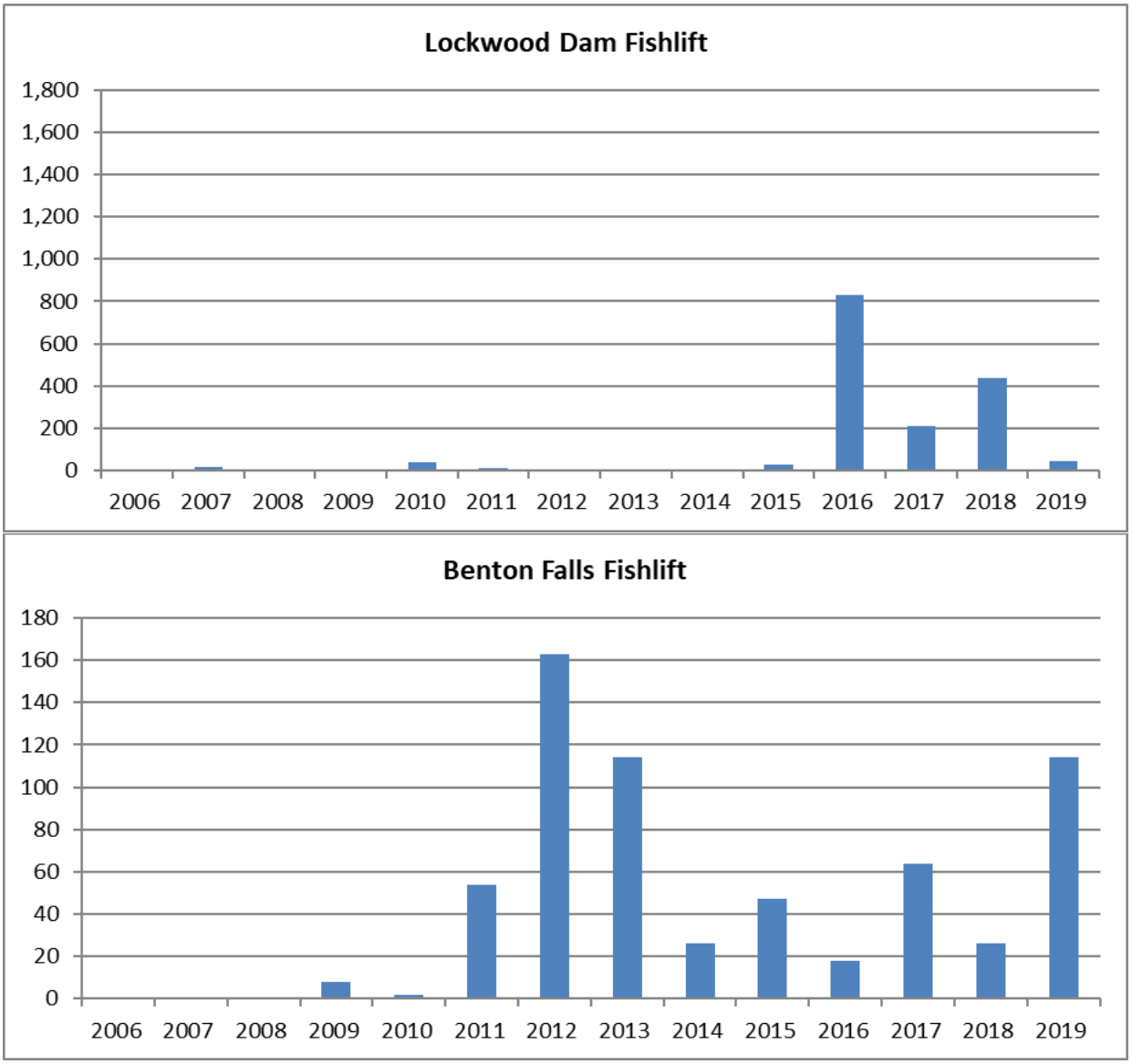

Figure 8. American shad passage at two counting locations in the Kennebec watershed. Fish passage was not operational before 2006.

Goals and Recommended Actions

- Ground-truth spawning habitat in the mainstem Kennebec and Sebasticook rivers
- Conduct population estimates for spawning adults
- Map young-of-year habitat based on existing beach seine surveys
- Develop fishway efficiency studies at Benton Falls and Lockwood fish lifts
- Conduct downstream passage studies at Benton Falls for both adult and juvenile American shad
- Monitor water chemistry (DO, turbidity, pH, temperature, conductivity) during spawning season
- Study impact of invasive species populations on shad populations

The timeline and associated costs of these recommended actions has not been determined.

Penobscot River

Amount of Habitat

The Penobscot watershed contains 786.3 river kilometers of potential American shad habitat. Of this, only 399.6 river kilometers are currently accessible (though accessibility to habitat above dams with fish passage is limited), while the remaining 386.7 river kilometers are inaccessible due to obstructed fish passage (Table 1).

Though few adult shad have been captured at the lower mainstem dams as part of fishway operations, recent summer trawl surveys conducted in the lower portion of the river have captured juvenile American shad (Lipsky and Saunders 2013). In 2004, 12 juvenile American shad were electrofished downstream of the Veazie Dam but none were captured during extensive upriver sampling (mainstem Penobscot from Veazie to the confluence of the East and West Branch in East Millinocket, the West Branch Penobscot to the outlet of Seboomook Lake, the East Branch Penobscot to Grindstone Falls, the Piscataquis River, the Stillwater River, Passadumkeag Stream, Pushaw Stream, and Millinocket Stream) (Yoder et al. 2004).

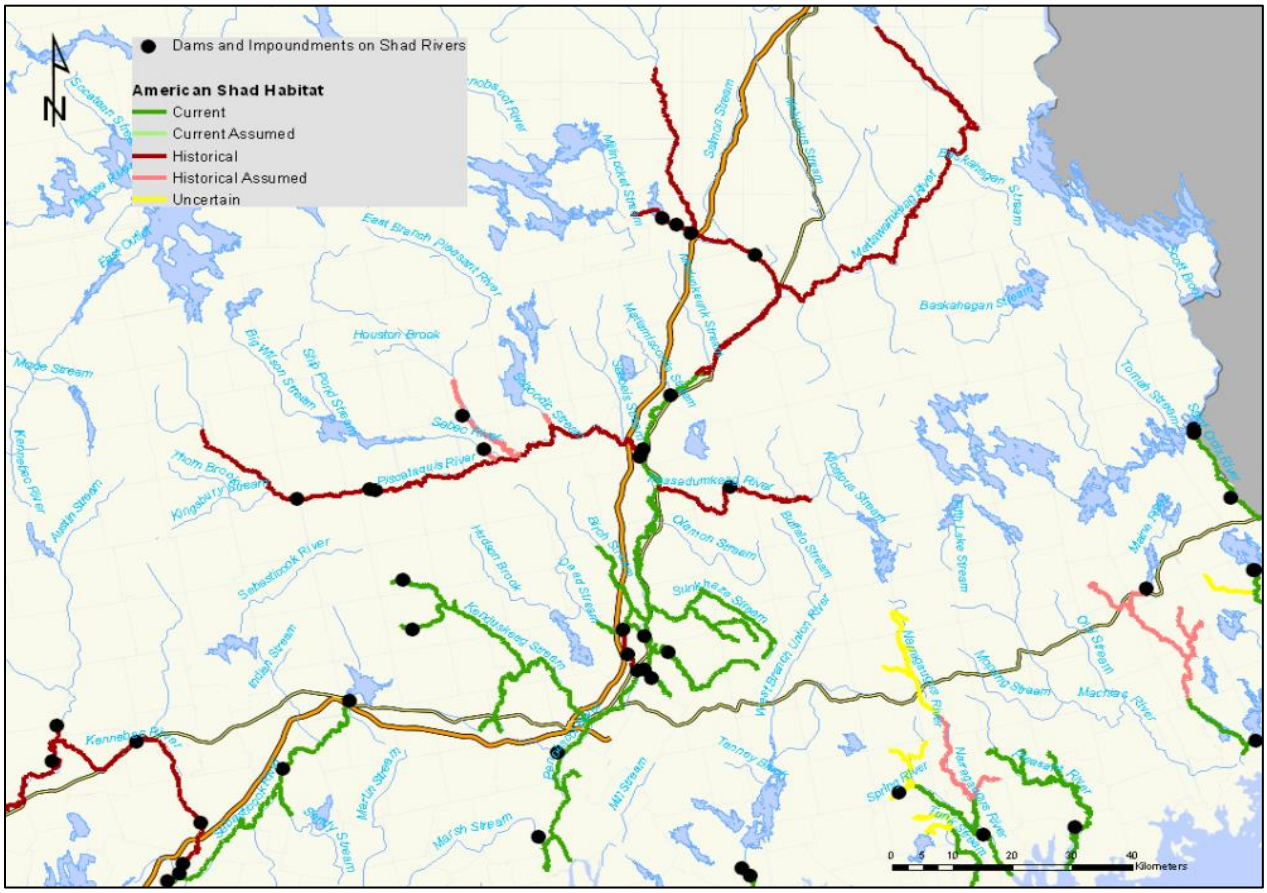

Figure 9. American shad habitat in Penobscot watershed. Historical habitat is above dams with no fish passage. The upper portion of the Kennebec River also is shown at the bottom left the figure, and the Narraguagus, Pleasant, and East Machias rivers appear in the bottom right.

Available Data

- Adult American shad counts, Maine DMR
- Fish community survey data, NOAA
- Maine DEP water quality reports
- USFWS. 1983. American Shad Habitat in the Gulf of Maine. http://www.fws.gov/r5gomp/gom/habitatstudy/metadata/shadhab83.htm
- USFWS. 2013. GIS Data at the Gulf of Maine Coastal Program. http://www.fws.gov/r5gomp/gisindex.htm

Threat(s)

- Barriers to migration
- Possible water quality

Barriers to migration. Until recently, mainstem dams in the lower portion of the Penobscot River have limited fish passage by all species, and reduced the amount of spawning habitat for American shad by more than half of the potential area. In 2004, the Lower Penobscot River Settlement Accord was signed, a multi-party agreement which laid the framework for the Penobscot River Restoration Project (PRRP). Through this project, the Penobscot Trust purchased the Veazie, Great Works, and Howland Dams in 2010 with the goal of dam removal or fish passage at each location. Five major projects are part of this effort to improve migratory fish passage and habitat in the lower Penobscot River:

- Removal of Great Works Dam in 2012
- Upgrade of Old Town Fuel & Fiber water intake in 2012 to reduce fish interaction
- Removal of Veazie Dam in 2013
- Installation of a fish lift at Milford Dam in 2013; and
- Decommissioning and construction of a bypass at Howland Dam

Before these projects were completed, limited access was available to American shad by way of upstream passage at the Veazie Dam, and two Denil fishways at the Great Works Dam.

Water quality. In the early 20th century, severe water pollution from upstream industries and municipalities had had a significant impact on fish populations. Water pollution improvement efforts that began in the early 1970s resulted in the dramatic improvement of water quality, however many paper mills and other industry still operate on the river. While the PRRP has addressed some known issues with water intake, others may exist.

Agencies with Regulatory Authority

Maine DMR, USFWS, NOAA, Maine DEP, Black Bear Hydro Partners, LLC, Penobscot River Restoration Trust, PPL Corporation

Other Organizations

Penobscot Indian Nation, American Rivers, Atlantic Salmon Federation, Maine Audubon, Natural Resources Council of Maine, and Trout Unlimited

Current Action and Progress

Barrier removal and passage facilities. Recent work has opened habitat in the lower portion of the Penobscot River through removal of the Great Works and Veazie dams, and upcoming installation of a fish lift at Milford Dam and bypass at the Howland Dam. The result of these projects on American shad will likely not been seen for a few years.

Before the Veazie Dam was removed, few American shad were provided upstream passage at the fish trap installed at that dam – since 1978, fewer than twenty adult spawning shad were passed. It is likely that the majority of shad in the Penobscot River remained below the dam, and any spawning occurred in the mainstem.

Fish community surveys. NOAA Northeast Fishery Science Center (NEFSC) Maine Field Station has conducted fish community monitoring since 2010 in the Penobscot Estuary. The survey has relied on a combination of fixed (seine and fyke) and mobile (trawl) capture gear combined with mobile hydroacoustics to describe relative abundance and species composition in the estuary. Sampling has generally occurred from April through October at weekly to monthly intervals depending on the year, season and gear. Twelve seine sites are distributed from 10 to 40 kilometers downstream of head-tide, four fyke sites at 12 and 25 kilometers downstream of head-tide and trawls from 15 to 55 kilometers downstream of head-tide. A total of 67 species have been identified including 10 diadromous, 27 freshwater and 30 marine life histories. Most dominant in the surveys by number are the clupeids namely *Clupea harengus* with *Alosa* species most common in percent occurrence. The survey has been successful in establishing systematic methods of sampling and has provided a platform for several researchers interested in estuary species such as: *Salmo salar, Fundulus heteroclitus, Osmerus mordax, Microgadus tomcod, Alosa pseudoharengus, Alosa aestivalis*, and *Alosa sapidissima*.

One of the objectives of the Penobscot Estuary survey was to describe temporal and spatial distributions of diadromous species including American shad. It is believed the Penobscot has a remnant population of American shad through anecdotal reports from anglers and infrequent occurrence at the Veazie Dam fishway trap operated by the Maine DMR. Seine surveys conducted in collaboration with the Maine DMR in 2010 - 2012, confirmed presence of young-of-year (YOY) American shad in the estuary and 2011-2013 trawl surveys have confirmed presence of age- 1 juveniles. Lipsky and Saunders (2013) summarized YOY distribution in the Penobscot and determined that due to salinity intolerance, the YOY are likely the result of natural reproduction from the Penobscot rather than larval drift from other spawning locations.

Seine and fyke catch data have shown that most (40% of total) YOY shad are captured in September but are present from July through November. Captures were most common (45% of total) in the tidal freshwater reaches of the estuary, 8-15 kilometers below head of tide. However, captures did occur in higher salinity (10-20 ppt) areas over 45 kilometers from head of tide. Trawl data suggests some age- 1 American shad utilize the Penobscot estuary in their second summer for rearing. Trawls in 2011 to 2013 have captured 750 individuals between 9 and 27 cm total length. For the trawl, most captures occur at the high turbidity, salinity mixing zone 20 to 30 kilometers downstream of head tide.

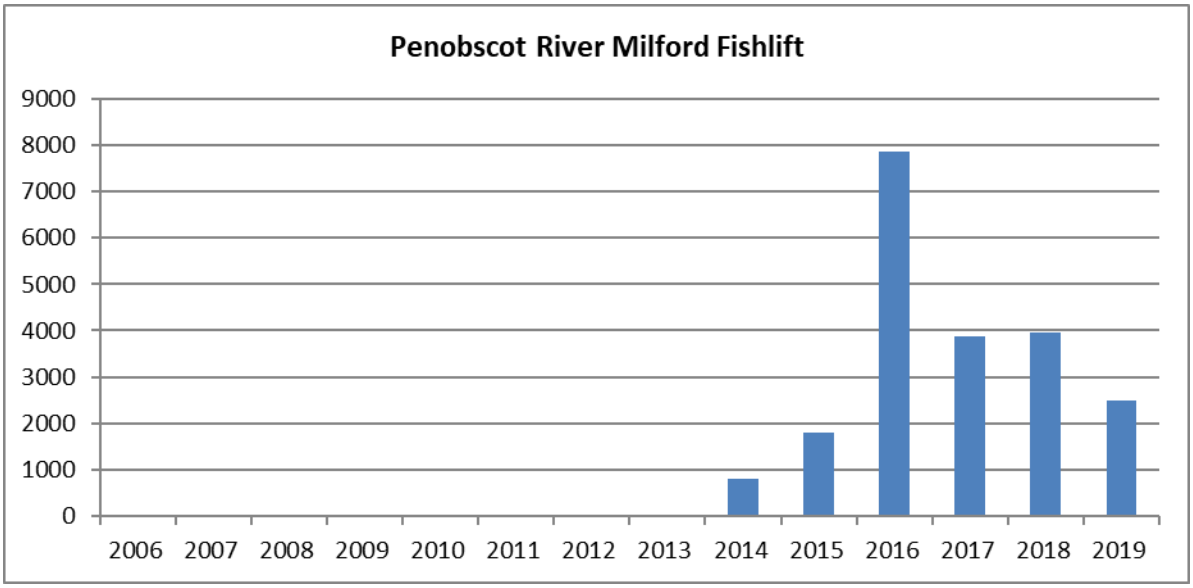

Figure 9. American shad passage at the Milford fish lift in the Penobscot River watershed. Fish passage was not operational before 2014.

Goals and Recommended Actions

- Ground-truth spawning habitat in the lower Penobscot River once the PRRP current objectives are complete
- Conduct population estimates for spawning adults
- Map young-of-year habitat based on existing beach seine surveys
- Develop fishway efficiency studies at Milford fish lift after sufficient time has passed for shad populations that may have spawned below the Great Works Dam have "found" their way upstream (part of current FERC license)
- Conduct downstream passage studies at Milford fish lift for both adult and juvenile American shad
- Monitor water chemistry (DO, turbidity, pH, temperature, conductivity) during spawning season
- Continued work to open habitat further upstream

Timeline

Current summer trawl surveys have documents American shad juveniles in the Penobscot River, however, with the large-scale changes occurring under the PRRP, dedicated work towards identifying spawning habitat and performing fish passage efficiency studies may be more productive after sufficient time has passed to allow fish populations to respond. Under the assumption that the PRRP work will be complete by 2016, it is suggested that the above recommendations be implemented in 2021, with the exception of water chemistry sampling which should be implemented at the Milford fish lift when it is operational. Adult shad counts and fish community surveys should continue annually.

Associated Costs

To accomplish the goals of the PRRP, it is estimated that ~$55 million is needed (Penobscot Restoration Trust 2013).

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American Shad Habitat Plan for New Hampshire Coastal Rivers

New Hampshire Fish & Game Department
Marine Fisheries Division

December 2020

This habitat plan is submitted by the New Hampshire Fish and Game Department as a requirement of Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring. Historically populations of American shad have been present in the coastal waters of New Hampshire including the Merrimack River, Connecticut River, and major tributaries of Great Bay Estuary. However, over the past 30 years of monitoring by the Department the number of returning American shad adults has been highly variable and in significant decline over the past 10 years. This plan outlines the current and historic habitat for American shad within NH coastal rivers. The greatest threat identified to the successful restoration of the species is the presence of dams along the rivers. Dams fragment the habitat and may further reduce the numbers entering fresh water due to the absence of a fish passage structure or poor passage efficacy for American shad of the existing structure.

The 2020 Atlantic States Marine Fisheries Commission's American Shad Stock Assessment and Peer Review Report provides an extensive review of available literature and discussion on the topic of fish passage (ASMFC 2020). Specifically, it highlights the issues with lack of evaluation and performance from decades-old approaches, facilities designs/operations that are not effective, and therefore cannot reasonably be expected to achieve management and restoration goals without significant changes. The Assessment Report also provides an important quantitative modeling approach examining shad habitat and passage barriers, and the need to address status quo fish passage performance. The impacts of these barriers and status quo passage are described and also modeled as effects on spawner population size under three scenarios, 1) no barriers, 2) first barrier with no passage, and 3) realistic fish passage performance measures applied to barriers (e.g., upstream passage efficiency of 50%).

The Assessment Report used standardized data and modelling approaches that quantified the impacts of barriers and fish passage as significant in all three management areas examined based on shad life history and habitat (New England, Mid-Atlantic, and South Atlantic). The assessment determined that overall, dams completely or partly block nearly 40% of the total habitat once used by American Shad. The model results of the "no barriers" scenario yielded an estimated spawner production potential 1.7 times greater than that yielded by the scenario assuming no passage at the first barrier: 72.8 million versus 42.8 million fish. The results of the third model scenario, which applies "realistic" (i.e., current) fish passage efficiencies, resulted in a gain of less than 3 million fish. Conclusions include "losses in (spawner production) potential are significant in each state and region." The Assessment Report provides a strong justification for the need and benefits of requiring improved fish passage performance measures. Additionally, meeting such improved passage performance standards is now an achievable goal given the

current state of knowledge on fish behavior, swimming performance, and fish passage engineering expertise.

1) **Habitat Assessment**

a) Spawning Habitat

Exeter River:

i) Amount of historical in-river and estuarine spawning habitat:

The headwaters of the Exeter River are in Chester, NH and the river flows approximately 75.7 rkm into Great Bay in Newfields, NH. The current surface area of the Exeter River from headwaters to river mouth is approximately 246.6 hectares. The tidal portion of the surface area accounts for half of the total area (123.6 hectares). These surface areas were calculated from current water levels and include impoundments created by existing dams which would reduce total surface area upon their removal.

ii) Amount of currently accessible in-river and estuarine spawning habitat (i.e., habitat accessible to adult fish during the upstream spawning migration).

Anadromous fish, including American shad, currently have access to approximately 38.1 rkm, which includes 10.2 rkm of tidal waters. The freshwater access for American shad spawning area is the remaining 27.9 rkm and is bounded upriver by Crawley Falls in Brentwood, NH. Currently access is available to 62.0 hectares of the freshwater portion of the Exeter River, or approximately 25% of the total surface area of the river.

Lamprey River:

i) *Amount of historical in-river and estuarine spawning habitat:*

The headwaters of the Lamprey River are in Northwood, NH and the river flows approximately 80.2 rkm into Great Bay in Newmarket, NH. The current surface area of the Lamprey River from headwaters to river mouth is approximately 255.7 hectares. The tidal portion of the surface area accounts for 15% of the total area (38.1 hectares). These surface areas were calculated from current water levels and include impoundments created by existing dams which would reduce total surface area upon their removal.

ii) *Amount of currently accessible in-river and estuarine spawning habitat (i.e., habitat accessible to adult fish during the upstream spawning migration).*

Anadromous fish, including American shad, currently have access to approximately 21.4 rkm, which includes 3.0 rkm of tidal waters until reaching the Macallen Dam Fish Ladder in Newmarket, NH. The freshwater access for American shad spawning area is the remaining 18.4 rkm and is bounded upriver by the Wadleigh Falls Dam site (breached) in Lee, NH. Currently access is available to 68 hectares of the freshwater portion of the Lamprey River, or approximately 31% of the total surface area of the river.

b) Rearing Habitat

i) Amount of historical in-river and estuarine young-of-year rearing habitat (e.g., river kilometers, water surface area (hectares)).

In addition to the in-river spawning habitat for each of the rivers, American shad have access to 2,494.4 hectares of possible rearing habitat in Great Bay Estuary. Below the estuary, the Piscataqua River flows an additional 21.14 rkm to the Atlantic Ocean with a surface area of approximately 2,106.3 hectares including Little Harbor.

ii) Amount of currently utilized in-river and estuarine young-of-year rearing habitat (i.e., habitat available to larval stage and young-of-year fish through natural spawning or artificial stocking of hatchery reared juvenile fish).

The amount of rearing habitat that is currently used is unknown, but the amount of available rearing habitat is equal to the accessible spawning habitat (*see sections "a)", part "i" above*) within each river plus the estuarine habitat identified (*see sections "b)", part "I" above*).

2) **Threats *Assessment*** – *Inventory and assess the critical threats to habitat quality, quantity, access, and utilization (see - Appendix C for a detailed habitat description). For those threats deemed by the state or jurisdiction to be of critical importance to restoration or management of an American shad stock, the state or jurisdiction should develop a threats assessment for inclusion in the Habitat Plan. Examples of potential threats to habitat quality, quantity, and access for American shad stocks include:*

a) Barriers to migration inventory and assessment

i) Inventory of dams, as feasible, that impact migration and utilization of historic stock (river) specific habitat. Attribute data for each dam should be captured in an electronic database (e.g., spreadsheet) and include: name of dam, purpose of the dam, owner, height, width, length, impoundment size, water

storage capacity, location (i.e., river name, state, town, distance from river mouth, geo-reference coordinates), fish passage facilities and measures implemented (i.e., fish passage type, capacity, effectiveness, and operational measure such as directed spill to facilitate downstream passage), and information source (e.g., state dam inventory).

I. Exeter River:

Description:
The Exeter River drains an area of 326 square km in southern NH. The river flows east and north from the Town of Chester to the Town of Exeter. It empties into Great Bay northeast of Exeter. The head-of-tide occurs at the Town of Exeter and the saltwater portion of the river is called the Squamscott River.

There is one man-made barrier to American shad migration on the main stem Exeter River. The Pickpocket Dam in Brentwood occurs at river kilometer 22.4 and is 4.6 meters high. The New Hampshire Fish & Game Department (NHFGD) constructed a Denil fishway at the dam sometime around 1970 for anadromous fish. There is no downstream fish passage facility on the dam so emigrating adult and juvenile shad must pass over the spillway when river flows allow. The next barrier above Pickpocket Dam is a natural waterfall at rkm 38.1.

Recommended Action:
Due to low shad numbers in the Exeter River, it is unknown how effective the Pickpocket Dam fishway is at shad passage. With higher shad returns to the Pickpocket Dam fishway, efficiency could be determined.

Regulatory Agencies/Contacts:
Dam Owners:
Pickpocket Dam:
The Town of Exeter, NH
Public Works Department
Jennifer R. Perry
13 Newfields Rd, Exeter, NH 03833

The Dam Bureau of the New Hampshire Department of Environmental Services (NHDES) oversees the maintenance, construction, and operation of all dams in the state.

NH Department of Environmental Services, Dam Bureau
James Gallagher
29 Hazen Dr, Concord, NH 03302-0095

The NHFGD owns and operates the fishway at Pickpocket Dam and facilitates implementation, monitoring, and oversight of fish passage.

Current Action:

The fishway at the Pickpocket Dam is monitored daily from early April to late June each year to allow for the passage of river herring, American shad, and other diadromous fish to historical spawning and nursery areas. All shad passing through the fishway are captured in the trap at the top, enumerated, and passed upstream by hand. Biological samples consisting of length measurement, sex determination, and scale samples used for age determination are attempted to be collected from each shad that returns.

Goals/Target:
It is the goal of NHFGD to remove or provide passage around/over as many barriers to the migration of anadromous fish in the Exeter River as possible to provide access to historical spawning habitat. This requires the continued maintenance and operation of the existing fish ladder and efforts to identify barriers further upstream where passage may be provided through modification or restoration. Efforts should be made to increase usage of the Pickpocket Dam fishway through river/fishway modifications or complete dam removal which would allow any returning American shad access to habitat upstream.

Timeline:
No timeline has been established for improving the usage of the fishway, but NHFGD will continue monitoring the fishway and identified barriers to fish passage and will work to increase the amount of spawning habitat available to anadromous fish in the Exeter River.

Progress:
Both the former fishway at Great Dam (removed in 2016) and Pickpocket Dam have been monitored since the early 1970's. During the period 2010-2019 only two American shad have returned to the Exeter River.

In addition, NHFGD continues to work to identify barriers to anadromous fish passage within the Exeter River and work towards a resolution.

III. Lamprey River

Description:
The Lamprey River flows approximately 80 km through southern New Hampshire to the Town of Newmarket where it becomes tidal and enters the Great Bay estuary just north of the mouth of the Squamscott River. There are three potential man-made barriers to American shad migration on the main stem of the river. The Macallen Dam, located at rkm 3.8 in Newmarket, is the lowermost head-of-tide dam on the Lamprey River, and has a standard denil fishway constructed by NHFGD between 1969 and 1970. There is no downstream passage facility at the Macallen Dam and emigrating juveniles and adults must pass over the spillway. The Wiswall Dam is located 4.8 rkm above the Macallen Dam at rkm 8.6. A standard denil fishway and downstream notch for emigration of juveniles and adults were constructed in 2012. A third potential manmade barrier, Wadleigh Falls Dam (breached), occurs 12.4 rkm above Wiswall

Dam at rkm 21.4 and the ability/inability of passage by American shad at the site is currently undetermined.

Recommended Action(s):
Determine success of American shad passage through the recently constructed standard denil fish ladder at the Wiswall Dam and assess the ability of passage over the breached Wadleigh Falls Dam If passage of anadromous fish, including American shad, is not possible then efforts should be made to work with landowners and partner agencies to allow fish to pass the barrier.

Due to low returns of American shad to the Lamprey River in recent years, it is unknown if American shad currently reach the Wiswall dam and use the standard denil fish ladder to continue upriver to the third potential barrier, Wadleigh Falls.

Regulatory Agencies/Contacts:
Dam Owners:

Macallen Dam:
The Town of Newmarket, NH
Newmarket Community Development Center
Rick Malasky
186 Main Street, Newmarket, NH 03857

Wiswall Dam:
The Town of Durham, NH
Public Works Department
Richard Reine or April Talon
100 Stone Quarry Drive, Durham, NH 03824

Wadleigh Falls Dam (breached):
Mr. Dodge
RR1, Rte 152, Lee, NH 03824

The Dam Bureau of the New Hampshire Department of Environmental Services (NHDES) oversees the maintenance, construction, and operation of all dams in the state.

NH Department of Environmental Services, Dam Bureau
James Gallagher
29 Hazen Dr, Concord, NH 03301

The NHFGD owns and operates the fishway at Macallen Dam and the Town of Durham, NH owns the fishway at Wiswall Dam and NHFGD facilitates implementation, monitoring, and oversight of fish passage.

Current Action:
The fishways at the Macallen and Wiswall Dams are monitored from early April to late June each year to allow for the passage of river herring, American shad, and other

diadromous fish to historical spawning and nursery areas. All shad passing through the Macallen fishway are captured in the trap at the top, enumerated, and passed upstream by hand. Biological samples consisting of length measurement, sex determination, and scale samples used for age determination are attempted to be collected from each shad that returns. The fishway at Wiswall Dam is operated as a swim through with no trap at the top.

Currently the Town of Newmarket is making modifications to increase the flood capacity of Macallen Dam during large rain events. They are replacing the old flood gate structure with pneumatic crest gates to increase spillway capacity. In addition, the right side dam abutment has been elevated to decrease the flood risk to an adjacent building.

Goals/Target:
It is the goal of NHFGD to remove or provide passage around/over as many barriers to the migration of anadromous fish in the Lamprey River as possible to provide access to historical spawning habitat. This requires the continued maintenance and operation of existing fish ladders and efforts to identify barriers further upstream such as Wadleigh Falls Dam (breached) where passage may be provided through modification or restoration.

Timeline:
No timeline has been established, but NHFGD will continue monitoring the fishways and identified barriers to fish passage and will work to increase the amount of spawning habitat available to anadromous fish in the Lamprey River.

Progress:
The fishway at Macallen Dam has been monitored since the early 1970's. Average annual return of American shad to the Macallen Dam fishway from 2010-2019 is less than one shad/yr. The Wiswall Dam fishway has been monitored since construction completed in 2012 through volunteer counting efforts and NHFGD electronic fish counters to estimate passage numbers and maintain ladder conditions conducive to fish passage during the spring.

NHFGD conducted a radio tagging study with river herring in 2013 to determine the passage success of river herring over the Wadleigh Falls Dam location (breached). The study results confirmed that Wadleigh Falls is a barrier to the passage of river herring. Unfortunately we are unable to determine if American shad can ascend Wadleigh Falls due the lack of returning fish.

ii) *Inventory of other human–induced physical structures (e.g., stream crossing/culverts), as feasible, that impact migration and utilization of historic habitat (data on each structural impediment should include: type, source, and location)*-**DATA CURRENTLY NOT AVAILABLE**

iii) *Inventory of altered water quality (e.g., low oxygen zones) and quantity (e.g., regulated minimum flows that impact migration corridors and/or migration cues), as feasible, impediments that impact migration and utilization of historic habitat (data on each water quality and quantity impediment should include: type, source, location, and extent).* **DATA CURRENTLY NOT AVAILABLE**

iv) *Assess barriers to migration in the watershed and characterize potential impact on American shad migration and utilization of historic habitat.*

(See part "I" above)

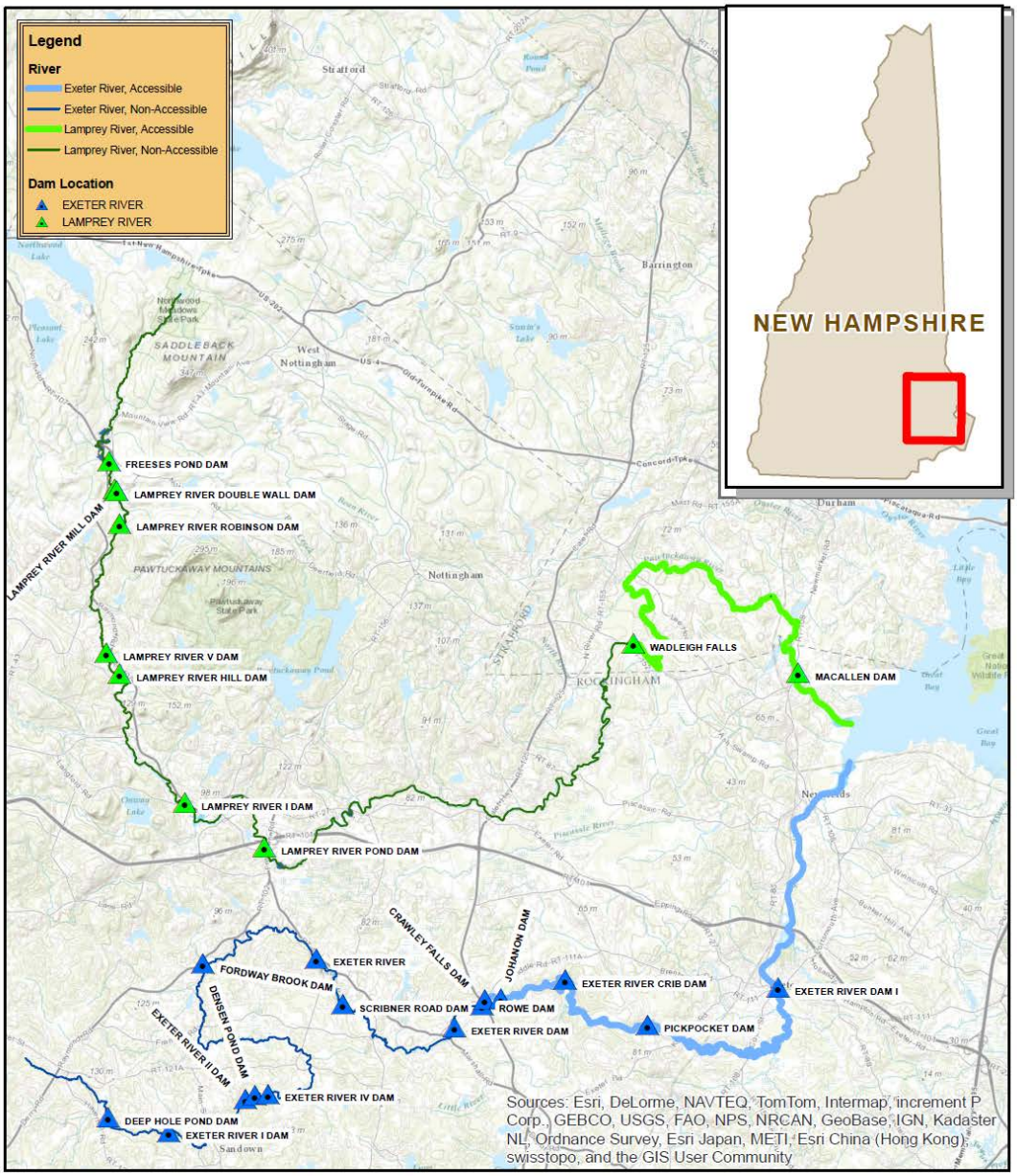
b) *Water withdrawals inventory and assessment* – **DATA CURRENTLY NOT AVAILABLE**
c) *Toxic and thermal discharge inventory and assessment-* **DATA CURRRENTLY NOT AVAILABLE**
d) *Channelization and dredging inventory and assessment-* **DATA CURRRENTLY NOT AVAILABLE**
e) Land use inventory and assessment- **DATA CURRRENTLY NOT AVAILABLE**
f) *Atmospheric deposition assessment-* **DATA CURRRENTLY NOT AVAILABLE**
g) *Climate change assessment-* **DATA CURRRENTLY NOT AVAILABLE**
h) *Competition and predation by invasive and managed species assessment-* **DATA CURRRENTLY NOT AVAILABLE**

Table 1. Inventory of Dams on the Exeter and Lamprey Rivers

RIVER	DAM NAME	COUNTY	TOWN	TYPE	STATUS	STATUS DATE	NH DAM ID	NATIONAL DAM ID	LENGTH	HEIGHT	BUILT	REBUILT	DAM LOCATION LONG	DAM LOCATION LAT	River km
EXETER RIVER	EXETER RIVER DAM I	ROCKINGHAM	EXETER	CONCRETE	REMOVED	2016	82.01	NH00304	140	15	1914	1968	-70.944444	42.98111	10.3
	PICKPOCKET DAM	ROCKINGHAM	BRENTWOOD	CONCRETE	ACTIVE	2004	29.07	NH00294	230	15	1920		-71.001667	42.96944	22.4
	EXETER RIVER CRIB DAM	ROCKINGHAM	BRENTWOOD	TIMBERCOMB	RUINS	1935	29.06		110	12			-71.036944	42.98417	27.6
	JOHANON DAM	ROCKINGHAM	BRENTWOOD	STONE/EARTH	RUINS	1935	29.05		60	10			-71.065	42.97806	31.5
	CRAWLEY FALLS DAM	ROCKINGHAM	BRENTWOOD	TIMBERCOMB	RUINS	1972	29.04		140	9			-71.072778	42.97778	32.2
	ROWE DAM	ROCKINGHAM	BRENTWOOD	TIMBERCOMB	RUINS	1935	29.03		80	8			-71.073889	42.97639	32.5
	EXETER RIVER DAM	ROCKINGHAM	BRENTWOOD	CONCRETE	ACTIVE	2007	29.01	NH00293	115	15	1900		-71.085833	42.96917	34.0
	SCRIBNER ROAD DAM	ROCKINGHAM	FREMONT	CONCRETE	ACTIVE	2003	89.02	NH01050	150	12	1963		-71.134167	42.97694	40.7
	EXETER RIVER	ROCKINGHAM	FREMONT	TIMBERCOMB	ACTIVE	1972	89.01	NH01876	70	7			-71.146389	42.99167	43.0
	FORDWAY BROOK DAM	ROCKINGHAM	RAYMOND	TIMBERCOMB	RUINS	0	201.1		0	1			-71.195	42.99056	49.9
	EXETER RIVER IV DAM	ROCKINGHAM	SANDOWN	STONE/EARTH	RUINS	1935	212.04		125	12			-71.166667	42.94861	62.7
	DENSEN POND DAM	ROCKINGHAM	SANDOWN	EARTH	ACTIVE	1996	212.03	NH03047	200	10	PRE 1935		-71.1725	42.94806	63.3
	EXETER RIVER II DAM	ROCKINGHAM	SANDOWN	STONE/EARTH	BREACHED	1982	212.02		100	10			-71.176667	42.94667	63.7
	EXETER RIVER I DAM	ROCKINGHAM	SANDOWN	EARTH/STONE	BREACHED	1949	212.01		0	5			-71.209722	42.93667	68.3
	DEEP HOLE POND DAM	ROCKINGHAM	CHESTER	EARTH	ACTIVE	2006	44.08	NH01003	150	15	1974		-71.2375	42.94111	71.2
LAMPREY RIVER	MACALLEN DAM	ROCKINGHAM	NEWMARKET	CONCRETE	ACTIVE	2003	177.01	NH00365	150	27	1887		-70.934722	43.08111	3.0
	WISWALL DAM	STRAFFORD	DURHAM	CONCRETE	ACTIVE	2005	71.04	NH00441	200	18	1911		-70.963333	43.10389	8.6
	WADLEIGH FALLS	STRAFFORD	LEE	CONCRETE	BREACHED	1997	135.02		300	13			-71.006667	43.09139	21.4
	LAMPREY RIVER POND DAM	ROCKINGHAM	RAYMOND		RUINS	1935	201.07		0	0			-71.167778	43.02833	48.1
	LAMPREY RIVER I DAM	ROCKINGHAM	RAYMOND		RUINS	1935	201.06		0	0			-71.2025	43.04139	54.0
	LAMPREY RIVER HILL DAM	ROCKINGHAM	DEERFIELD	STONE/EARTH	RUINS	1935	61.06		0	5			-71.230278	43.0825	61.5
	LAMPREY RIVER V DAM	ROCKINGHAM	DEERFIELD	STONE/EARTH	EXEMPT	1979	61.08	NH01656	125	2			-71.236944	43.09	62.6
	LAMPREY RIVER ROBINSON DAM	ROCKINGHAM	DEERFIELD		RUINS	0	61.05		0	0			-71.229167	43.13056	68.5
	LAMPREY RIVER DOUBLE WALL DAM	ROCKINGHAM	DEERFIELD	STONE/EARTH	RUINS	1934	61.04		0	12			-71.231111	43.14083	70.1
	LAMPREY RIVER MILL DAM	ROCKINGHAM	DEERFIELD	STONE/EARTH	RUINS	1934	61.03		0	15			-71.232222	43.14167	70.2
	FREESES POND DAM	ROCKINGHAM	DEERFIELD	CONCRETE	ACTIVE	2001	61.02	NH00472	150	12.5	1987		-71.234444	43.15028	71.4

Accessible Spawning Habitat and Barrier Inventory of Exeter and Lamprey Rivers, NH

American Shad Habitat Plan



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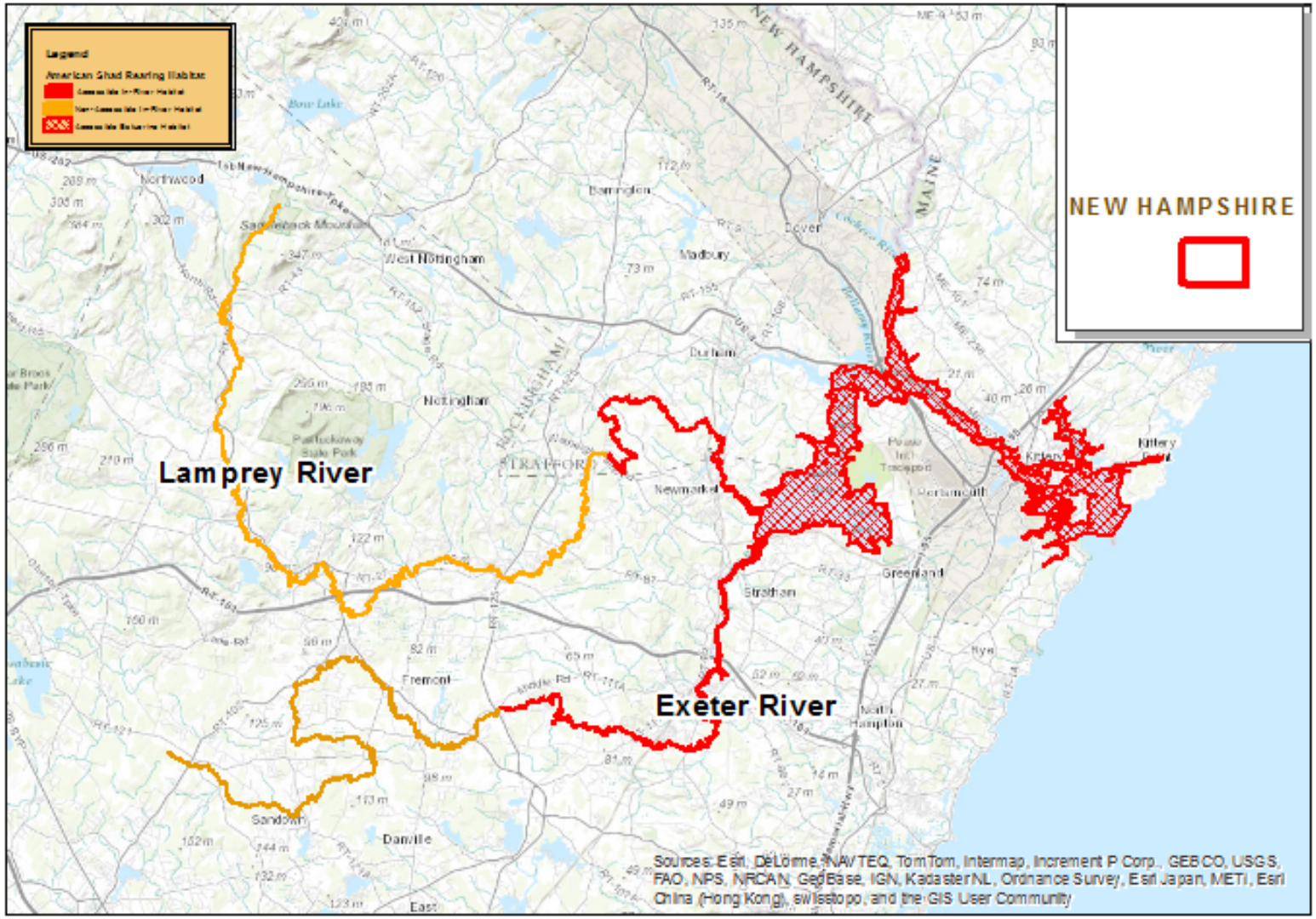
Rearing Habitat for American Shad in the Exeter and Lamprey Rivers, NH

American Shad Habitat Plan



0 1 2 4 6 8 Miles

N W E S

MARYLAND DEPARTMENT OF NATURAL RESOURCES

Larry Hogan, Governor
Boyd Rutherford, Lt. Governor
Jeannie Haddaway-Riccio, Secretary

Maryland's American Shad Habitat Plan

Submitted to the
Atlantic States Marine Fisheries Commission

Prepared by
Robert J. Bourdon
Maryland Department of Natural Resources
Fishing and Boating Services

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December 21, 2020

Maryland's American Shad Habitat Plan

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Thank you to Margaret McGinty and Jim Uphoff of the Maryland Department of Natural Resources Fisheries Habitat and Ecosystem Program for providing expertise on habitat issues facing American shad and for their assistance with habitat delineation.

Habitat Assessment

Spawning and rearing habitat was determined for most major river systems under Maryland jurisdiction with a known history of American shad (*Alosa sapidissima*) spawning (Tables 1 & 2). Spawning habitat was delineated using a combination of empirical observations during scientific surveys, spring salinity regimes (MDNR, 2020), historical fishery reports, and the Chesapeake Fish Passage Prioritization tool (Martin, 2019) (Figures 1-9). Rearing habitat was delineated using a combination of empirical observations during scientific surveys and juvenile American shad distribution estimates formulated by the MDNR Fisheries Habitat and Ecosystem Program (FHEP) (Figure 10; Uphoff et al., 2017). Rearing habitat was further categorized according to average bottom salinity (1998-2003) into preferred (0-4 ppt), acceptable (4-7 ppt), and marginal (7-13 ppt) habitat (Uphoff et al., 2017). Salinity preferences were determined using frequency distributions of young-of-year American shad captured during the MDNR Estuarine Juvenile Finfish Survey by salinity (Uphoff et al., 2017).

Most rivers were assessed individually, with the only exception being the complex of waterways that feed into the upper Chesapeake Bay, which was combined into single estimates of spawning and rearing habitat. This was done in accordance with the 2020 benchmark stock assessment which identified this collection of rivers as a single stock unit (ASMFC, 2020). These rivers include Chesapeake Bay tributaries such as the Susquehanna, North East, Elk, Bohemia, and Sassafras Rivers. While spawning can occur in any of these locations, the Susquehanna River, Susquehanna Flats, and North East River are host to the majority of American shad spawning activity in the Upper Bay. While this may be partially a function of the currently depressed stock status, historical fishery landings suggest that even in times of greater abundance, spawning runs of American shad were minimal in the Elk and Sassafras Rivers relative to the Susquehanna River and Flats (Stevenson, 1899; Mansueti and Kolb, 1953; Walburg and Nichols, 1967). Stevenson (1899) even suggested that American shad often bypassed small rivers such as the Sassafras due to their attraction to the strong freshwater flow coming from the Susquehanna River.

Habitat statistics as presented in this document should be interpreted as accessible habitat rather than suitable habitat; some historically productive and accessible rivers have been significantly degraded by urban and agricultural development, leading to less than favorable environmental conditions for American shad spawning. Such rivers include the Patapsco, Patuxent, and Wicomico. The impacts of these issues on habitat quantity are variable from year to year and difficult to assess. Thus, they are addressed in the 'Threats' section of this habitat plan. Nevertheless, most dams or other anthropogenic barriers in Maryland are located far

enough upstream so as not to impact American shad use of habitat. Habitat upstream of dams with fish passage facilities was considered accessible if American shad have been documented successfully using the fish ladder/lift.

Threats Assessment

Threat: Barriers to Migration

An inventory of dams that may be encountered by American shad are included in Table 3. As stated previously, most of the dams in Maryland are located far enough up the watershed so as to not impact American shad habitat use. The primary exception to this is Conowingo Dam on the Susquehanna River, which restricts access to a substantial amount of upriver spawning and rearing habitat. Only 4.38% of historical American shad habitat in the Susquehanna River drainage remains unobstructed (ASMFC, 2020). Further complicating habitat use in the Susquehanna River basin are three other major hydropower dams (Holtwood, Safe Harbor, and York Haven Dams) upstream of Conowingo, all located in Pennsylvania. The majority of suitable spawning habitat lies beyond York Haven, the most upstream of these dams. While fish passage facilities exist at all of these hydropower projects, upstream passage efficiency is poor. Mean combined upstream passage efficiency of adult American shad from all four main steam dams from 1997-2010 was estimated as 2% (Normandeau and Gomez & Sullivan, 2012a). Upstream passage efficiency of adult American shad at Conowingo Dam alone is estimated as 25.8% (Normandeau and Gomez & Sullivan, 2012b).

Despite the presence of volitional fish passage at Conowingo Dam, significant upstream passage delays are likely. Increased residence time in the dam tailrace results in greater energy expenditure during an already metabolically-costly migration. Consequences of upstream passage delays, in conjunction with poor upstream passage efficiency and downstream migration mortality, include reduced fecundity, spatial extent of spawning, spawning success, spawner abundance, and percentage of repeat spawners (Stich et al., 2018; Castro-Santos and Letcher, 2010).

As a result significantly reduced habitat accessibility, the abundance of American shad spawning in the Susquehanna River is likely near historic lows (Bourdon and Jarzynski, 2019). However, the pending relicensing of Conowingo Dam, along with ongoing upstream and downstream fish passage improvements at dams in the Pennsylvania portion of the Susquehanna, should improve riverine migratory conditions for American shad and other diadromous species.

Updating upstream and downstream passage requirements to ecologically-informed levels at major hydropower dams is essential for the restoration of American shad. In times past, losses due to poor adult downstream survival through the Susquehanna River dams essentially replaced losses due to fisheries (Sadzinski and Uphoff, pers. comm). Substantial work to improve downstream adult survival is ongoing and includes solutions such as installation of Kaplan turbines (more fish-friendly than traditional Francis turbines), seasonal alterations to turbine and spillway operations, and creation of alternative routes of downstream passage. At

smaller dams throughout the state, the MDNR Fish Passage Program (FPP) prioritizes dam removal over fish passage facility installation.

The failure of fish passage facilities to restore alosine fish populations is not unique to the Susquehanna and is a ubiquitous problem throughout the range of the American shad (Brown et al., 2012). The 2020 ASMFC American shad stock assessment report highlights issues with lack of evaluation and performance standards at fish passage facilities (ASMFC, 2020). Many of these structures are decades old and their designs and operations are largely ineffective; they cannot reasonably be expected to achieve management and restoration goals without significant changes. The assessment report also provides a quantitative modeling approach examining shad habitat and passage barriers, and the need to address status quo fish passage performance. The impacts of these barriers and status quo passage are described and also modeled as effects on spawner population size under three scenarios: 1) no barriers, 2) first barrier with no passage, and 3) realistic fish passage performance measures applied to barriers (e.g., upstream passage efficiency of 50%).

The assessment report used standardized data and modelling approaches that quantified the impacts of barriers and fish passage as significant in all three management areas examined based on American shad life history and habitat (New England, Mid-Atlantic, and South Atlantic). Overall, dams completely or partly block nearly 40% of the total habitat once used by American Shad. The model results of the "no barriers" scenario yielded an estimated spawner production potential 1.7 times greater than that yielded by the scenario assuming no passage at the first barrier: 72.8 million versus 42.8 million fish. The results of the third model scenario, which applies "realistic" (i.e., current) fish passage efficiencies, resulted in a gain of less than 3 million fish. Losses in spawner production potential were significant in each state and region. The assessment report provides a strong justification for the need and benefits of requiring improved fish passage performance measures. Additionally, meeting such improved passage performance standards is now an achievable goal given the current state of knowledge on fish behavior, swimming performance, and fish passage engineering expertise.

Recommended Action 1 (See Task A1 in SRAFRC Restoration Plan): Develop and implement upstream passage plans and performance measures at the Conowingo hydroelectric dam to ensure that the facility passes at least 85 percent of the adult American shad reaching the tailrace. Incorporate upstream passage plans and evaluation requirements in FERC licenses. Recommend or conduct evaluation studies as necessary. Require additional fish passage capacity, as needed, to meet fish passage targets. Report fish passage results annually.

> **Agencies with Regulatory Authority:** SRAFRC (made up of MDNR, PFBC, PADEP, SRBC, NYDEC, and USFWS members), MDE, and FERC.
> **Goal/Target:** Goals listed in the recommended action are to be met in conjunction with FERC relicensing and compliance.
> **Progress:** In April 2016, Exelon Generation LLC entered a settlement agreement with the USFWS regarding the fish passage prescription for Conowingo dam. This fish passage settlement agreement outlines the steps that will be taken to achieve the required upstream passage efficiency. The MDE and Exelon Generation LLC reached a settlement agreement in Fall 2019 regarding the water quality certification issued in 2018 by

Maryland under Section 401 of the Clean Water Act. Relicensure of Conowingo dam, and thus the implementation of upstream passage requirements, is still pending FERC approval of both the fish passage and water quality settlement agreements.
Cost: SRAFRC member agencies are responsible for overhead. The dam owner's cost is dependent on the level of fishway improvement required to meet target levels.
Timeline: Action goals are to be accomplished upon completion of FERC relicensing.

Recommended Action 2 (See Task A2 in SRAFRC Restoration Plan): Develop and implement downstream passage plans and measures for adult alosine species at the Conowingo hydroelectric dam to ensure at least 80 percent survival. Incorporate adult downstream passage plan and evaluation requirements in FERC licenses.

Agencies with Regulatory Authority: SRAFRC (made up of MDNR, PFBC, PADEP, SRBC, NYDEC, and USFWS members), and FERC.
Goal/Target: Goals listed in the recommended action are to be met in conjunction with FERC relicensing and compliance.
Progress: In April 2016, Exelon Generation LLC entered a settlement agreement with the USFWS regarding the fish passage prescription for Conowingo dam. This fish passage settlement agreement outlines the steps that will be taken to achieve the required downstream passage efficiency. The MDE and Exelon Generation LLC reached a settlement agreement in Fall 2019 regarding the water quality certification issued in 2018 by Maryland under Section 401 of the Clean Water Act. Relicensure of Conowingo dam, and thus the implementation of downstream passage requirements, is still pending FERC approval of both the fish passage and water quality settlement agreements.
Cost: SRAFRC member agencies are responsible for overhead. The dam owner's cost is dependent on the level of modification required to meet target levels.
Timeline: Action goals are to be accomplished upon completion of FERC relicensing.

Recommended Action 3 (See Task A3 in SRAFRC Restoration Plan): Develop and implement juvenile downstream passage plan and performance measures at the Conowingo hydroelectric dam to ensure 95 percent survival of juvenile alosine species at this facility. Incorporate juvenile downstream passage plan and evaluation requirements in FERC licenses. Include operational measures at the hydroelectric dam as needed to enhance downstream passage survival of juvenile alosine species.

Agencies with Regulatory Authority: SRAFRC (made up of MDNR, PFBC, PADEP, SRBC, NYDEC, and USFWS members), and FERC.
Goal/Target: Goals listed in the recommended action are to be met in conjunction with FERC relicensing and compliance.
Progress: In April 2016, Exelon Generation LLC entered a settlement agreement with the USFWS regarding the fish passage prescription for Conowingo dam. This fish passage settlement agreement outlines the steps that will be taken to achieve the required downstream passage efficiency. The MDE and Exelon Generation LLC reached a settlement agreement in Fall 2019 regarding the water quality certification issued in 2018 by Maryland under Section 401 of the Clean Water Act. Relicensure of Conowingo dam,

and thus the implementation of downstream passage requirements, is still pending FERC approval of both the fish passage and water quality settlement agreements.
Cost: SRAFRC member agencies are responsible for overhead. The dam owner's cost is dependent on the level of modification required to meet target levels.
Timeline: Action goals are to be accomplished upon completion of FERC relicensing.

Recommended Action 4 (See Task A9 in SRAFRC Restoration Plan): Minimize delays at the Conowingo hydroelectric dam to foster adult spawning fish migration to the upper limits of historical spawning habitat in the watershed.

Agencies with Regulatory Authority: SRAFRC (made up of MDNR, PFBC, PADEP, SRBC, NYDEC, and USFWS members), and FERC.
Goal/Target: Goals listed in the recommended action are to be met in conjunction with FERC relicensing and compliance.
Progress: In April 2016, Exelon Generation LLC entered a settlement agreement with the USFWS regarding the fish passage prescription for Conowingo dam. This fish passage settlement agreement outlines the steps that will be taken to ensure the timely upstream passage of American shad. The MDE and Exelon Generation LLC reached a settlement agreement in Fall 2019 regarding the water quality certification issued in 2018 by Maryland under Section 401 of the Clean Water Act. Relicensure of Conowingo dam, and thus the implementation of upstream passage requirements, is still pending FERC approval of both the fish passage and water quality settlement agreements.
Cost: SRAFRC member agencies are responsible for overhead. The dam owner's cost is dependent on the level of fishway improvement required to meet target levels.
Timeline: Action goals are to be accomplished upon completion of FERC relicensing.

Recommended Action 5: To continue to provide for fish passage at dams, and remove stream blockages wherever necessary to restore passage for migratory fishes to historical spawning grounds.

Agencies with Regulatory Authority: MDNR, in cooperation with the Chesapeake Bay Program, Pennsylvania, Virginia, and the District of Columbia.
Goal/Target: MDNR has been part of the Chesapeake Bay Agreement (to provide fish passage at dams and remove stream blockages) since 1987. After exceeding the initial goal by restoring access to 1,838 miles of aquatic habitat by 2005, the states decided to expand the goal to 3,500 miles by 2025. As of 2017, this goal was surpassed with a cumulative restoration total of 3,746 miles. The Chesapeake Bay Agreement prioritizes dam removals over the installation of fish ladders.
Progress: To date, the MDNR FPP has completed 78 projects, reopening a total 454.2 miles of upstream aquatic habitat (in Maryland). The FPP is currently involved in planning for the removal of three dams that American shad may encounter including Van Bibber Dam (Bush River), Atkisson Dam (Bush River), and Ft. Meade Dam (Patuxent River). Additionally, there are plans to improve natural bypass conditions around the Elkton Dam (Elk River).
Cost: Total cost and responsible agencies depend on the project. In Maryland, participants include but are not limited to MDNR, American Rivers, NFWF, NOAA, CBP, EBTJV, and the USFWS.

Timeline: Between 1989 and 2011, 2,510 miles of aquatic habitat were re-opened to migratory fish in the Chesapeake Bay watershed. In accordance with the Chesapeake Bay Watershed Agreement, the CBP adopted a goal of re-opening an additional 1,000 miles from the 2011 baseline. As of 2017, this goal was exceeded with access to 1,236 miles of aquatic habitat being restored.

Threat: Water Withdrawals

Power plant cooling water intakes currently account for over 91% of permitted surface water withdrawals by volume in Maryland. Cooling water intakes in excess of two-million gallons per day are regulated by the EPA National Pollutant Discharge Elimination System (NPDES). An inventory of power plants that currently withdraw water from Maryland's portion Chesapeake basin within American shad habitat are provided in Table 4. No American shad have been documented in either entrainment or impingement studies conducted at these facilities. However, other alosids such alewife and blueback herring have been infrequently documented, which would suggest that juvenile American shad could be subject to entrainment or impingement in small numbers.

The Maryland Department of the Environment (MDE) regulates surface water intake requirements for power plants drawing under two-million gallons per day as well as intakes for most other purposes. Any operation withdrawing in excess of 10,000 gallons of surface water must obtain a water appropriation and use permit from MDE. Consultation with the MDNR environmental review team is conducted for all new surface water withdrawals. Concurrent with MDNR recommendations, MDE requires a 0.5 ft/second intake velocity and one millimeter screening on most surface water intakes. While alosine fish habitat is considered during the permitting process, most water intakes do not require monitoring for impingement or entrainment of aquatic organisms.

Recommended Action: Reduce impingement and entrainment of American shad within the Maryland portion of the Chesapeake basin.

Agencies with Regulatory Authority: EPA, FERC, MDE, MDNR
Goal/Target: NA
Progress: All power plants drawing in excess of two-million gallons of surface water per day within the range of American shad have conducted impingement monitoring, and all but one (Wheelabrator) have conducted entrainment monitoring. No American shad were identified by these studies. MDE requires a 0.5 ft/second intake velocity and one millimeter screening to reduce entrainment and impingement of aquatic organisms. Additionally, the MDNR Power Plant Research Program initiated the Smart Siting Project in 1996 to provide guidance to power plant developers regarding environmental concerns and to identify areas most favorable for power plant development.
Cost: NA
Timeline: NA

Recommended Action: Maintain surface water flow velocity and volume sufficient for American shad spawning and rearing.

Agencies with Regulatory Authority: EPA, FERC, MDE, MDNR
Goal/Target: NA
Progress: The MDNR Environmental Review Team and MDE consider the impacts of proposed surface water withdrawals on flow regimes to maintain appropriate conditions for aquatic life.
Cost: NA
Timeline: NA

Threat: Channelization and dredging

There is no information available regarding the impacts of dredging projects on American shad in Maryland, though fish habitat may be given consideration during the permitting process. Alteration of substrate characteristics could influence spawning behavior, though American shad may not be as substrate specific as some other alosine species (Krauthamer and Richkus, 1987; Bilkovic et al., 2002). Disturbance of the benthos may also temporarily decrease water quality and suspend contaminants in the water column, especially in urban or industrial areas.

The largest dredging projects in Maryland are managed by the Maryland Department of Transportation's Maryland Port Authority (MPA) and are operated to maintain shipping channels connecting the main stem of the Chesapeake Bay and the Patapsco River (location of the Port of Baltimore). An average of 4.7 million cubic yards of sediment is dredged every year to maintain approximately 150 nautical miles of shipping channels. Most of the MPA authorized dredging occurs outside of the preferred spawning or rearing habitat for American shad, with the exception being the Upper Bay area where a 35-40' channel system is maintained to connect the Port of Baltimore to the Chesapeake and Delaware canal. Smaller dredging projects are permitted through MDE.

The MPA also manages the Dredged Material Management Program to find environmentally responsible solutions for the usage of dredged material. Much of this material is used for habitat restoration on eroding Chesapeake Bay islands and marshes. Active dredged material placements sites include Poplar Island, Masonville, and Cox Creek. The MDE oversees the proper use of dredged material, including the enforcement of sediment characterization requirements that ensure that contaminated dredged material does not negatively impact aquatic communities.

Recommended Action: Consider American shad habitat during the permitting process for dredging and dredged material placement projects.

Agencies with Regulatory Authority: MDOT, MPA, MDE
Goal/Target: NA
Progress: MDE may consult the MDNR Environmental Review Team during the permitting process for dredging projects. MPA and MDE are both involved in site selection for the reuse of dredged material. MDE considers toxicity thresholds for aquatic communities during sediment characterization studies required before the placement of

dredged material. To offset the impacts of dredging, the MPA funded shad and river herring restoration in the Patapsco River through fish production, stocking, and assessment.
Cost: NA
Timeline: NA

Threat: Land Use

Land use has a profound impact on water quality and fisheries health within Maryland. Many fish stocks, including American shad, have experienced significant declines due to uninformed land use decisions among other factors. One of the earliest realized effects of poorly regulated land use on fisheries in Maryland was the siltation of anadromous fish spawning grounds (Mansueti and Kolb, 1953). While American shad spawning may not be as substrate dependent as some other alosines (Krauthamer and Richkus, 1987; Bilkovic et al., 2002), siltation of spawning grounds contributed to American shad declines in Maryland in the early 20th century (Mansueti and Kolb, 1953; Klauda et al., 1991a). The topography of watersheds on the western shore of the Chesapeake Bay may promote rapid runoff of surface water into rivers and streams, especially when natural land cover has been disturbed. The American shad spawning grounds of one such watershed, the Patuxent, suffered under heavy siltation associated with gravel mining and tobacco farming in the early to mid-1900's (Mansueti and Kolb, 1953). The degree of siltation in most eastern shore rivers during that time was likely not as severe, despite the prevalence of agriculture; the flat land does not promote rapid runoff of surface water into rivers (Mansueti and Kolb, 1953). Siltation from flood stages at Conowingo Dam likely restricted spawning habitat on the Susquehanna Flats in the Upper Bay soon after dam construction in 1928. Fishermen in the region reported that they could no longer operate drift nets over the Susquehanna Flats due to the degree of siltation and sunken logs deposited from upstream (Mansueti and Kolb, 1953).

Modern best management practices currently prevent siltation from occurring on such large scales, but localized siltation events still occur. Streambank erosion in headwater streams and the discharge of legacy sediments stored in stream valleys continue to impact aquatic ecosystem health (Noe et al., 2020). Furthermore, sediment retention in Conowingo Reservoir is at maximum capacity; the discharge of water from the dam, particularly at flood stages, is now associated with the release of sediment and associated nutrients, heavy metals, and other pollutants that have accumulated behind the dam over the last century (Palinkas et al., 2019).

Few sampling programs have successfully monitored the impact of watershed development on American shad specifically. However, the MDNR Fisheries Habitat and Ecosystem Program (FHEP) assesses alosine fish habitat use across a gradient of development to explore the effects of urbanization on spawning habitat (Uphoff et al., 2019). The critical egg and larvae life stages are targeted by this survey. While no American have been detected to date, they are expected to demonstrate similar responses to development as the positively detected alosine species (river herring and hickory shad); American shad eggs and larvae have similar tolerances as other Maryland alosines for salinity, temperature, turbidity, pH, dissolved oxygen, and suspended solids (Klauda et al., 1991a; Klauda et al., 1991b).

The level of development in a watershed is often measured using a metric of impervious surface coverage (Topolski, 2015; Uphoff et al., 2019). Increases in impervious surfaces are associated with greater surface water runoff into surrounding waterways and declining water quality. This runoff acts as a vector for excess nitrogen, phosphorus, and contaminants such as heavy metals, dissolved minerals, and PAHs. The FHEP demonstrated that the presence of alosine eggs and larvae is negatively correlated with both the level of development and conductivity, a commonly used measure of water quality associated with development (Uphoff et al., 2019). These findings suggest that increases in urban and suburban development are causative factors of the deterioration of alosine spawning habitat and overall spawning success. Rivers impaired by high levels of development are unlikely to produce notable quantities of juvenile American shad, even if the abundance of spawners is sufficient (Uphoff et al., 2018).

Excess nutrient loading due to land development also has a significant influence on dissolved oxygen (DO) availability. Bottom water hypoxia significantly reduces available habitat for most aquatic species and is an annually observed phenomenon throughout most of the Chesapeake basin during the summer (Rabalais and Turner, 2001; Breitburg et al., 2003; D'Elia et al., 2003). Nutrient runoff from agricultural lands has often been implicated as a primary driver of seasonal hypoxic events in the Chesapeake Bay (Kemp et al., 2005; Brush, 2009). However, other types of human-altered land coverage negatively influence DO availability as well. Uphoff et al. (2011) demonstrated significant relationships between various modes of watershed land use, summer DO, and presence of finfish and shellfish indicator species in various Maryland sub-estuaries. Percent impervious surface coverage was used as an indicator of urban development intensity. Bottom DO was negatively influenced by impervious surface coverage while surface DO exhibited no relationship to impervious surface coverage. Surprisingly, mean bottom DO was positively correlated with the percentage of agricultural land cover. No matter the cause, summer hypoxia influences the amount and quality of rearing habitat available to American shad. However, the extent of summer hypoxia usually does not impact freshwater and oligohaline waters that compose the preferred rearing habitat identified by the FHEP (Figure 10; Uphoff et al., 2017). The mesohaline waters characteristic of acceptable and marginal rearing habitat are much more susceptible to hypoxic conditions (Figure 10; Uphoff et al., 2017). Exposure to hypoxic waters may cause direct mortality of finfish, or increase mortality indirectly through density-dependent interactions with predators, impaired growth, or suppressed immune responses among other factors (Breitburg, 2002; Breitburg et al., 2003, 2009).

Fisheries managers do not have authority to manage land use and are limited to managing the harvest of fishes that may be threatened. The FHEP works to tie land use and fisheries management together; this program's research supports a 10% impervious surface threshold as the 'tipping point' beyond which little success is expected in maintaining sustainable fisheries. A characterization of estimated impervious surface coverage, along with select other watershed characteristics, is provided for spawning and rearing rivers in Table 5. American shad fisheries are closed in Maryland, but an explanation of Maryland's watershed fishery management priorities are as follows (Figure 11):

- Conserve - areas with less than 5% impervious surface; recommend harvest restrictions and stocking for effective fisheries management and watershed conservation for sound land management.
- Revitalize – areas with 5-10% impervious surface; recommend options to decrease harvest and increase stocking to compensate for effective fishery management, and conserve and revitalize watershed for sound land management.
- Re-engineer – areas with 10-15% impervious surface; fisheries are highly variable; traditional fishery management tools are not reliable. Recommend conserving and reconstructing degraded watershed for land management – typically re-engineering will address nutrient reductions for larger scale TMDL, but this is not expected to have local biological lift.
- 15% impervious – from a fishery management point of view, investments to enhance large scale fisheries are not expected to be effective; local re-engineering can address localized habitat stability needs, but are not expected to provide additional ecological lift.

Recommended Action: To continue to promote the conservation and revitalization of watersheds, especially in areas vulnerable to growth. Conserving watersheds at a target level of development is ideal [0.27 structures per hectare (C/ha) or 5% impervious surface cover; Uphoff et al. 2018]. Once above this level of development, revitalization and reconstruction could consist of measures such as road salt management, stemming leaks in sewage pipes, improving septic systems, stormwater retrofits, stream rehabilitation, replenishment of riparian buffers, creation of wetlands, planting upland forests, and "daylighting" of buried streams (Uphoff et al. 2018). Other effects that may exacerbate development related habitat stressors (i.e., climate change) should also be considered.

Agencies with Regulatory Authority: The planning authority for each county is typically the local government, with the Maryland Department of Planning serving in an advisory capacity.
Goal/Target: Maryland does not have measureable goals for protecting American shad from land use impacts; fisheries managers can only influence land use in an advisory capacity. If the fishery reopens, management strategies may be adapted to the level of watershed development, as advised by the FHEP.
Progress: Maryland instituted a moratorium on American shad fisheries in 1980 to reduce stress on the depleted American shad stock. Many state and grassroots organizations work to preserve as much of the remaining natural land in Maryland as possible. The FHEP acts in an advisory capacity to local governments to promote natural land conservation and more responsible development practices.
Cost: NA
Timeline: NA

Threat: Climate Change Assessment

Diadromous fish, including American shad, are among the most vulnerable aquatic species to the effects of climate change (Hare et al., 2016). Of 36 Northeast U.S. continental shelf fish species analyzed in a spatial distribution study, American shad exhibited one of the

greatest poleward shifts in distribution during their marine residence from 1968-2007 (Nye et al., 2009). However, given the natal homing behavior exhibited by American shad, a northward shift of the same magnitude is unlikely for the spawning range, though there is greater uncertainty surrounding this prediction (Hare et al., 2016). Changes in stock structure due to climate change should be given greater consideration during future diadromous fish stock assessments (Nye et al., 2009).

American shad migration and spawning are heavily influenced by water temperature. Models focusing on American shad in the Hudson River, New York predict that by the 2090's, the onset of spawning will begin 15 days earlier and the duration of spawning will be truncated by 4 days (Nack et al., 2019). In Maryland, peak spawning time is mid-April through early June, with temperatures ranging from 55°F to 68°F. In addition to anticipated changes in spawning time and duration, spring temperature increases may lead to a mismatch between larval rearing phases and phytoplankton blooms required to support them (Boesch, 2008). The migration of juvenile alosine fish, including American shad, to the ocean in the fall is triggered by decreasing water temperature, and may be delayed due to warmer fall temperatures (Kane, 2013).

Maryland lies in the middle of the coastwide range of American shad, which minimizes the potential for distributional shifts of this species in the state. However, the impacts of climate change on American shad may manifest themselves in more indirect ways. The combined effects of temperature change, sea level rise, and changes to precipitation patterns will likely exacerbate the impacts of other threats described in this document including development and poor water quality (Boesch, 2008). Notably, temperature, freshwater flow, and sea level rise predictions specific to the Chesapeake Bay are expected to decrease dissolved oxygen availability in the basin despite substantial efforts to reduce nutrient inputs throughout the watershed (Irby et al., 2018). American shad, especially larvae and juveniles, may also experience stress due to changes in the abundance and distribution of food resources (Boesch, 2008); distributional shifts of other species in response to climate change may also increase competition for these resources and expose American shad to novel predatory interactions.

Recommended Action: Incorporate the effects of climate change on American shad migration, spawning, distribution, habitat, and trophic interactions into decisions impacting the management of anadromous fish stocks and habitat.

Agencies with Regulatory Authority: ASMFC, MAFMC, NMFS, MDNR
Goal/Target: NA
Progress: The Maryland Climate Change Commission advises the Governor and General Assembly "on ways to mitigate the causes of, prepare for, and adapt to the consequences of climate change." While this effort does not directly address the effects of climate change on American shad, it does promote ecosystem resiliency efforts which indirectly work to conserve anadromous fish habitat.
Cost: NA
Timeline: NA

Threat: Competition and Predation

American shad, particularly juveniles and sub-adults, are forage for a wide variety of species. Given their great historic abundance, young-of-year American shad were likely a common prey item for most piscivorous or generalist fish during the summer and fall in tidal Maryland waters. Presently, few, if any, predators have a stronger influence on American shad population dynamics than the striped bass (*Morone saxatilis*). Predation by striped bass has been identified as a driver of American shad population density in the Albemarle Sound (Tuomikoski et al., 2008). In the Connecticut River, predation by an increasing abundance of striped bass was implicated in the drastic decline of American shad in the 1990's (Savoy and Crecco, 2004). Being the primary spawning and nursery area for the coastal migratory stock, the Chesapeake Bay is home to an abundance of striped bass; annual fluctuations in the abundance of resident, pre-migratory striped bass likely exert a strong effect on successful recruitment of juvenile American shad to the offshore migratory stock.

The proliferation of invasive predators in Maryland waters is of particular concern to all alosine species. Blue catfish (*Ictalurus furcatus*), flathead catfish (*Pylodictis olivaris*), and Northern snakehead (*Channa argus*) are all recently introduced predators with the potential to impact American shad restoration efforts. Schmitt et al. (2017) analyzed prey selectivity of both flathead and blue catfish in the James River, a Virginia tributary of the Chesapeake Bay, during March-May of 2014 and 2015. They found that flathead catfish were highly piscivorous and selectively preyed on adult American shad relative to other available forage. Blue catfish had broad, omnivorous diets but became more piscivorous with age; predation upon adult American shad was documented, but there was no evidence for selectivity of American shad over other available forage. The impacts of Northern snakehead upon American shad are not well understood, but predation, especially upon juveniles, is likely (Fofonoff et al., 2003).

Migration obstacles such as dams that facilitate dense aggregations of American shad are likely to increase their susceptibility to predation by these species (Schmitt et al., 2017). In Maryland, this is mainly a concern at Conowingo dam, where high numbers of American shad congregate near the entrances of fish lifts. Flathead catfish, blue catfish, and Northern snakehead are also abundant in the Conowingo dam tailrace, so predation upon American shad is expected.

Flathead catfish are almost entirely restricted to freshwater habitats. Within Maryland, their most dense populations are located in the Susquehanna River and the non-tidal Potomac River, though they have also been documented in the Upper Chesapeake Bay, the Elk River, and the Sassafras River. Northern snakehead and especially blue catfish have proven themselves more adaptable to the primarily brackish waters of the Chesapeake basin and are now found in almost all Maryland tributaries. Therefore, the potential for the interaction of these species with both adult and juvenile American shad is high. Despite this, American shad population declines in response the proliferation of invasive predators has not been documented in Maryland. In the Potomac River, the epicenter of both the blue catfish and Northern snakehead invasions in the state, relative abundance of both juvenile and adult American shad continues to increase (Bourdon and Jarzynski, 2019). Further work is needed to fully understand the impacts that this suite of invasive predators may have on the recovery of American shad in Maryland waters.

Long established non-native predators such as the channel catfish (*Ictalurus punctatus*), smallmouth bass (*Micropterus dolomieu*), and largemouth bass (*Micropterus salmoides*) may also impede the recovery of alosine fish populations. Given the long history of these species in the Chesapeake basin, their impacts on American shad populations are unknown. However, all have been documented consuming American shad (Fofonoff et al., 2003). Most notably, juvenile smallmouth bass were the dominant predator of recently stocked larval American shad in the Susquehanna River (Johnson and Dropkin, 1992).

While many native species compete for food resources with American shad, the gizzard shad (*Dorosoma cepedianum*) presents particularly strong challenges for American shad recovery via non-predatory, density-dependent effects. Stocks of many native fish species declined throughout the 20th century due to a myriad of factors including deteriorating water quality and overfishing. However, gizzard shad thrived in this changing environment. There is substantial diet overlap between juvenile gizzard shad and young-of-year American shad, and gizzard shad have been implicated in the lack of recovery of American shad stocks in the Susquehanna River (Klauda et al., 1991a). High abundances of gizzard shad may also interfere with the ability of American shad to effectively utilize fish passage facilities, as has been observed at Conowingo Dam (SRAFRC, 2010). From 2010-2019, the East Fish Lift at Conowingo passed 1,090 gizzard shad per lift on average; the average passage of gizzard shad outnumbered American shad by a ratio of 80:1 during the same time period (Normandeau, 2019).

Recommended Action: Promote the commercial and recreational harvest of flathead catfish, blue catfish, and northern snakehead as means of population control.

Agencies with Regulatory Authority: MDNR, MDA, FDA, USDA

Goal/Target: Maryland has no specific goals or targets for population control of invasive finfish predators. Population reduction and stabilization will be promoted through commercial and recreational fisheries.

Progress: There are no creel limits or size restrictions on the recreational fisheries for the aforementioned species. Likewise, the commercial fishery operates under no size restrictions with an unlimited quota. MDNR has conducted extensive public outreach to encourage recreational harvest of these species. In 2018, the state of Maryland announced the Blue Catfish Purchasing Initiative, which promotes the sale of blue catfish to state institutions with food services. MDNR is currently supporting the Maryland General Assembly in an effort to overturn USDA inspection rules for catfish species which significantly hinder the harvest and sale of blue catfish. MDNR is currently drafting the Invasive Catfish Fishery Management Plan which will further outline goals to control invasive catfish in Maryland waters.

Cost: NA

Timeline: NA

Recommended Action: Control the further spread of flathead catfish, blue catfish, and northern snakehead in waters under Maryland jurisdiction.

Agencies with Regulatory Authority: MDNR, USFWS, SRAFRC (made up of MDNR, PFBC, PADEP, SRBC, NYDEC, and USFWS members), FERC

Goal/Target: Northern snakehead and blue catfish are already present in most rivers systems in the Chesapeake basin. Flathead catfish populations are more localized and restricted by salinity. Intentional spread of these species is prohibited.
Progress: While Northern snakehead and blue catfish are now present in most suitable waters in the Chesapeake basin, they are mostly absent upstream of Conowingo Dam. For the 2021 fish passage season, volitional passage to Conowingo Pond via the East Fish Lift (EFL) will not be conducted. Alternatively, the West Fish Lift (WFL) will pass anadromous fish upstream via a trap and truck transport program. Every effort will be made to sort the entire catch and remove invasive species captured in the WFL. Volitional upstream passage via the EFL will likely not resume until adequate procedures to control invasive species passage are implemented. Intentional release of invasive catfish or northern snakehead into a different waterbody from where it was caught is illegal in Maryland. Furthermore, it is illegal to possess, import, or transport a live northern snakehead.
Cost: NA
Timeline: NA

Habitat Restoration Programs

MDNR Fish Passage Program (FPP):
The FPP was established in the Chesapeake Bay Agreement in 1987. To date, the FPP has completed 78 projects, reopening a total 454.2 miles of anadromous fish habitat. The program favors dam removals over fish passage facility construction and priority is given to projects which open large stretches of the highest quality habitat. Additionally, priority is given to projects which enhance passage of migratory fish and where shad or river herring stocking programs operate.

MDNR Fish Hatcheries Division:
The MDNR Fish Hatcheries Division sources American shad broodstock from the Potomac River, operating under a collection permit from the Potomac River Fisheries Commission. Stocking of American shad began in 1994 in the Patuxent River. Since that time, stocking has been conducted in various tributaries including the Nanticoke River, Marshyhope Creek, the Choptank River, and the Patapsco River. Currently, American shad stocking occurs on the Choptank and Patapsco Rivers. From 1994-2019, the Fish Hatcheries Division stocked over 55-million American shad in Maryland waters.

Water Quality Improvement Program (Water withdrawals and thermal/toxic discharge):
No specific program exists to address the impacts of water withdrawals, thermal discharge, or toxic discharge on spawning success or juvenile recruitment of American shad. However, all power plants drawing in excess of two-million gallons of surface water per day within the range of American shad have conducted impingement monitoring, and all but one (Wheelabrator) have conducted entrainment monitoring. No American shad were identified by these studies. Consistent with MDNR recommendations, MDE requires a 0.5 ft/second intake velocity and one millimeter screening on all surface water withdrawals to reduce entrainment or impingement of aquatic organisms. Additionally, the MDNR Power Plant Research Program (PPRP) initiated the

Smart Siting Project in 1996 to provide guidance to power plant developers regarding environmental concerns and to identify areas most favorable for power plant development.

Habitat Improvement Programs:

Numerous state programs are involved with land acquisition and habitat improvement including Program Open Space, the Rural Legacy Program, the Maryland Environmental Trust, the Forest Legacy Program, and the Conservation Reserve Enhancement Program. To date, these programs have protected approximately 657,690 acres of state land. Various other county organizations and non-profits also work to conserve natural land throughout the state. While these land conservation efforts do not focus directly on anadromous fish habitat protection or restoration, American shad will benefit indirectly through the preservation of natural land cover. The MDNR FHEP has identified watershed management priorities throughout the Chesapeake basin (Figure 11); the FHEP advises state and county planners on land management decisions and how they relate to fish habitat and fisheries health.

Permit Review Process:

The MDE is the primary permitting agency in the state of Maryland for water withdrawals, channelization and dredging, and land use/development. The MDNR Environmental Review Team reviews most proposed projects; anadromous fish spawning areas identified by O'Dell et al. (1975, 1980) are considered during the review process. Other MDNR programs including the FHEP may periodically act as advisors to the environmental review process.

Maryland Climate Change Commission (MCCC):

The MCCC advises the Governor and General Assembly "on ways to mitigate the causes of, prepare for, and adapt to the consequences of climate change." While this effort does not directly address the effects of climate change on American shad, it does promote ecosystem resiliency efforts which indirectly work to conserve anadromous fish habitat.

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Table 1. Historical and currently accessible spawning habitat for American shad in waters regulated by the state of Maryland. River kilometer (rkm) habitat estimates incorporate both tidal and non-tidal spawning reaches. Habitat area estimates were only available for tidal sections of spawning reaches and are thus not a complete representation of spawning habitat.

System	Historical Habitat (rkm)	Current Habitat (rkm)	Percent Available	Historical Tidal Habitat Area (ha)	Current Tidal Habitat Area (ha)	Percent Available	Limited By
Chester	32.3	32.3	100.0	1,139	1,139	100.0	Habitat
Choptank	75.4	75.4	100.0	1,360	1,360	100.0	Habitat
Nanticoke	44.9	44.9	100.0	1,018	1,018	100.0	Habitat
Patapsco	45.9	34.4	75.0	76	76	100.0	Dam
Patuxent	71.9	71.9	100.0	869	869	100.0	Habitat
Pocomoke	62.9	62.9	100.0	761	761	100.0	Habitat
Upper Bay*	213.5	213.5	100.0	46,274	46,274	100.0	Habitat
Wicomico	26.1	21.0	80.3	400	348	86.9	Dams
TOTAL	**580.4**	**556.3**	**97.1**	**51,897**	**51,844**	**99.9**	

* The estimates presented in this table represent river km and habitat area estimates for all areas in the Upper Chesapeake Bay where spawning could theoretically occur. In reality, the bulk of American shad spawning activity in the Upper Chesapeake Bay occurs in the Susquehanna River, Susquehanna Flats, and North East River. This 'preferred' spawning area is composed of 53.1 rkm and 14,071 ha of habitat.

Table 2. Historical and currently accessible rearing habitat for American shad in waters regulated by the state of Maryland. Current habitat is only shown if it differs from historically available habitat. River kilometer (rkm) habitat estimates incorporate both tidal and non-tidal rearing areas. Habitat area estimates were only available for tidal sections of rearing areas and are thus not a complete representation of rearing habitat.

System	Historical Preferred Habitat (rkm)	Current Preferred Habitat (rkm)	Historical Acceptable Habitat (rkm)*	Historical Marginal Habitat (rkm)*	Historical Preferred Tidal Habitat (ha)*	Historical Acceptable Tidal Habitat (ha)*	Historical Marginal Tidal Habitat (ha)	Current Marginal Tidal Habitat (ha)	Limited By
Chester	31.0	31.0	14.9	61.1	1,028	945	9,966	9,966	Habitat
Choptank	85.5	85.5	16.3	123.9	1,445	1,118	29,479	29,479	Habitat
Nanticoke	49.4	49.4	2.6	15.9	2,086	341	4,299	4,299	Habitat
Patapsco	35.6	25.3		64.7			9,601	9,601	Dam
Patuxent	87.3	87.3	8.1	55.3	1,132	1,243	11,898	11,898	Habitat
Pocomoke	55.8	55.8	8.9	7.8	599	107	706	706	Habitat
Upper Bay	169.2	169.2			35,461				Habitat
Wicomico	7.1	0.0		56.7			2,037	1,985	Dams
TOTAL	**520.7**	**503.3**	**50.8**	**385.3**	**41,752**	**3,754**	**67,986**	**67,934**	

* 100% of historical habitat of this type is currently available.

Table 3. Inventory of riverine barriers that American shad can potentially encounter in waters regulated by the state of Maryland. Data on dam dimensions, storage, and drainage area were queried from the Maryland Department of the Environment's dam inventory unless otherwise noted.

Barrier Name	System	Passage Type	Latitude	Longitude	Dam Height (m)	Dam Length (m)	Normal Dam Storage (m^3)	Upstream Drainage Area (km^2)
Van Bibber Dam	Bush	Steeppass	39.4686252	-76.3347629	4.3	182.9	16,035	142
Jones Lake Dam	Chester	Steeppass	39.2469732	-75.8179534	4.0	359.7	40,705	112
Williston Mill Dam	Choptank	Denil	38.8277559	-75.8468516	5.5	192.0	481,057	20
Tuckahoe Dam	Choptank	Denil	38.9675226	-75.9425857	4.3	518.2	32,070	258
Rewastico Pond Dam	Nanticoke	None	38.4107288	-75.7536718	3.0	140.2	49,709	26
Galestown Mill Pond Dam	Nanticoke	Steeppass	38.5675008	-75.7133338	2.7	152.4	141,850	21
Mill Creek Dam	Nanticoke	None	38.5948363	-75.8267003	3.4	91.4	33,304	9
Lake Chambers Dam	Nanticoke	None	38.6963525	-75.7646134	3.4	118.9	27,137	14
Daniel's Dam	Patapsco	Denil	39.3147660	-76.8164480	8.2	137.2	634,009	688
Ft. Meade Dam	Patuxent	Denil	39.0927176	-76.7683366	2.7	21.3	4,934	313
Higgins Mill Pond Dam	Transquaking	None	38.5189625	-75.9646440	2.7	275.8	310,837	30
Elkton Dam	Upper Bay	Denil	39.6123677	-75.8172330	1.5	33.5	6,167	194
Wilson's Mill Dam	Upper Bay	Denil	39.6145948	-76.2060399	2.7	51.8	6,167	466
Conowingo Dam	Upper Bay	Lift	39.6612120	-76.1731769	32.0	1,415.5	382,378,800	69,930
Allen Town Pond Dam	Wicomico	None	38.2832350	-75.6889157	2.4	121.9	118,414	33
Camden Avenue Dam	Wicomico	None	38.3361100	-75.6133320	3.7	106.7	123,348	30
Anderson Mill Pond Dam	Wicomico	None	38.3557130	-75.6738657	3.4	73.2	48,106	15
Isabella Street Weir	Wicomico	None	38.3718872	-75.6027689	NA	NA	NA	100*

* Upstream drainage area for Isabella Street Weir was calculated using the USGS StreamStats Application

Table 4. Mean daily 2018 water withdrawal and entrainment and impingement of American shad by power plants in the Maryland portion of the Chesapeake basin.

Power Plant	System	Mean Daily 2018 Water Withdrawal (million gallons/day)	Entrainment	Impingement	Source
Calvert Cliffs	Chesapeake Bay	3350	0 (2006)	0 (1975-1995)	EA, 2008a; Ringger, 2000
Vienna	Nanticoke	0.0188	no data	no data	
Wagner	Patapsco	239	0 (2006-2007)	0 (2006-2007)	EA, 2008b
Wheelabrator	Patapsco	37.8	no data	0 (1985-1986)	EA, 2017
Chalk Point	Patuxent	268	0 (1977-1979)	0 (1976-1985)	EPRI, 2010
Morgantown	Potomac	819	0 (2007)	0 (2006-2007)	EPRI, 2009

Table 5. Watershed characteristics for American shad spawning rivers, queried from the USGS StreamStats application. Percent forest and impervious land surface coverage was estimated by the Maryland Department of Planning in 2010 unless otherwise noted. Percent developed land was estimated by the National Land Cover Database, combining land use classes 21-24.

System	Tributary	% Forest	% Impervious	% Developed	Drainage Area (km^2)
Upper Bay	Susquehanna	65.7*	1.7**	8.3	71,225
	North East	36.1	7.8	17.2	201
	Elk	27.1	6.1	17.4	679
	Bohemia				
	C&D Canal				
	Sassafras	22.3	2.2	5.3	248
Chester	Chester	21.5	2.5	6.8	1,230
Choptank	Choptank	21.4	3.6	7.6	2,049
Nanticoke	Nanticoke	27	3.5	7.3	2,142
Wicomico	Wicomico	36	10.6	19.4	482
Pocomoke	Pocomoke	54.4	2.2	5.8	1,261
Patuxent	Patuxent	40.1	13.5	25.3	2,401
Patapsco	Patapsco	25.9	23.7	44.2	1,567

* Maryland Department of Planning forest coverage data was not available for the entire Susquehanna watershed. The provided estimate is sourced from the enhanced 1992 National Land Cover Database.

** Maryland Department of Planning impervious surface coverage data was not available for the entire Susquehanna watershed. The provided estimate is sourced from the 2011 National Land Cover Database.

Figure 1. Chester River American shad spawning reach. The spawning pathway represents the path used for river km habitat estimates. All historical spawning habitat is currently accessible.

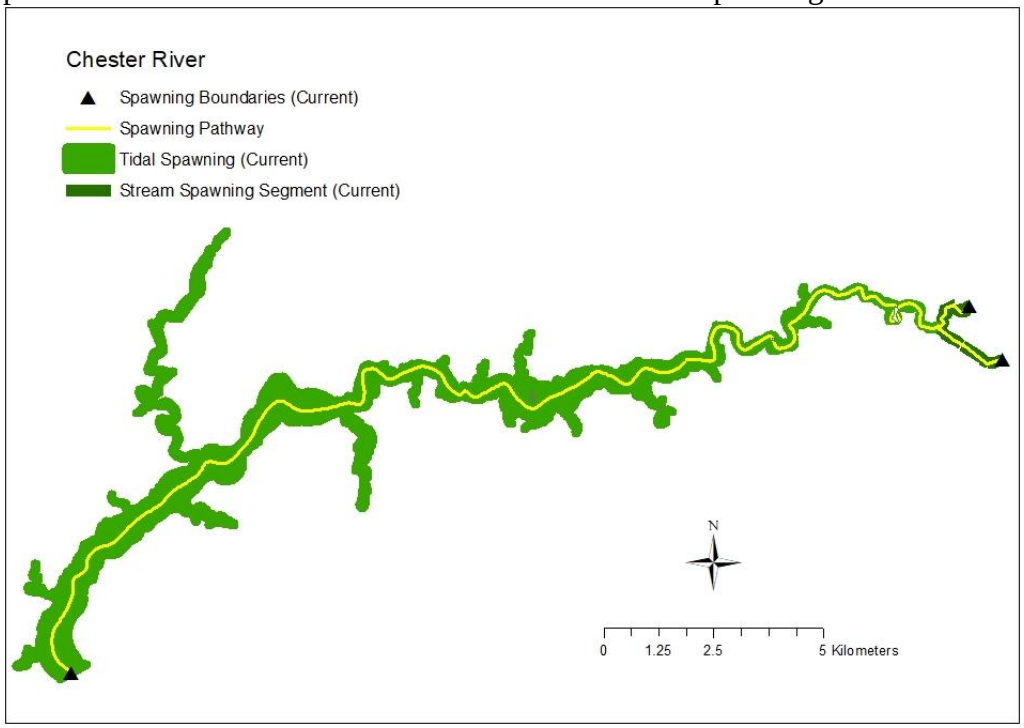


Figure 2. Choptank River American shad spawning reach. The spawning pathway represents the path used for river km habitat estimates. All historical spawning habitat is currently accessible.

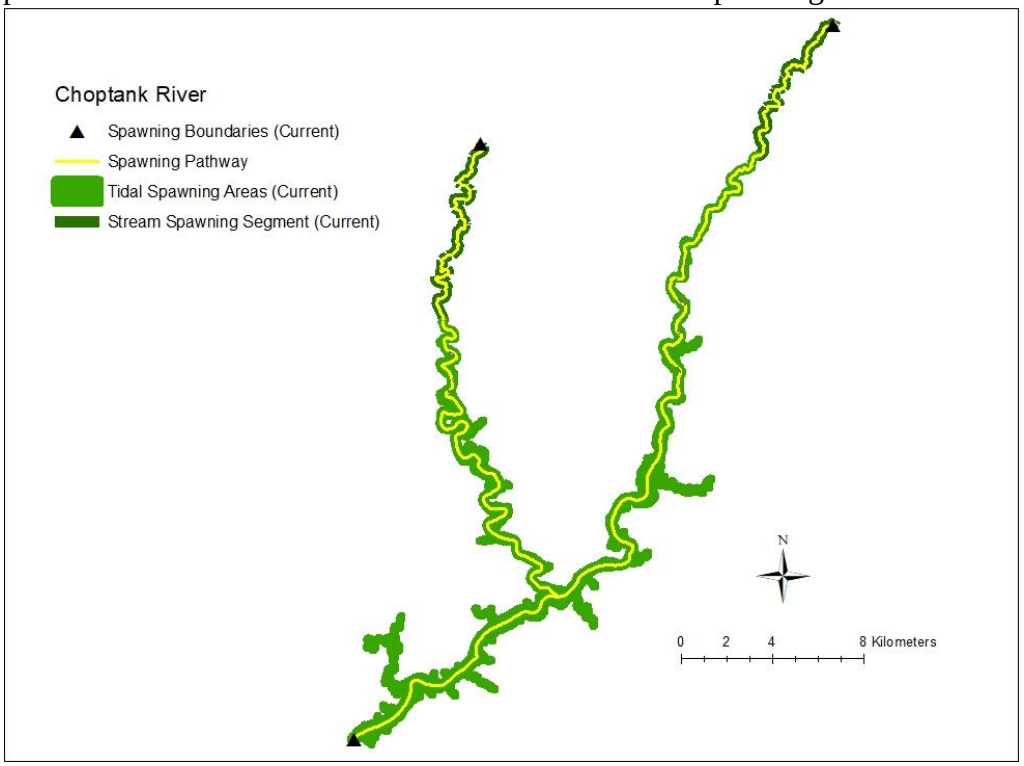


Figure 3. Nanticoke River American shad spawning reach. The spawning pathway represents the path used for river km habitat estimates. All historical spawning habitat is currently accessible.

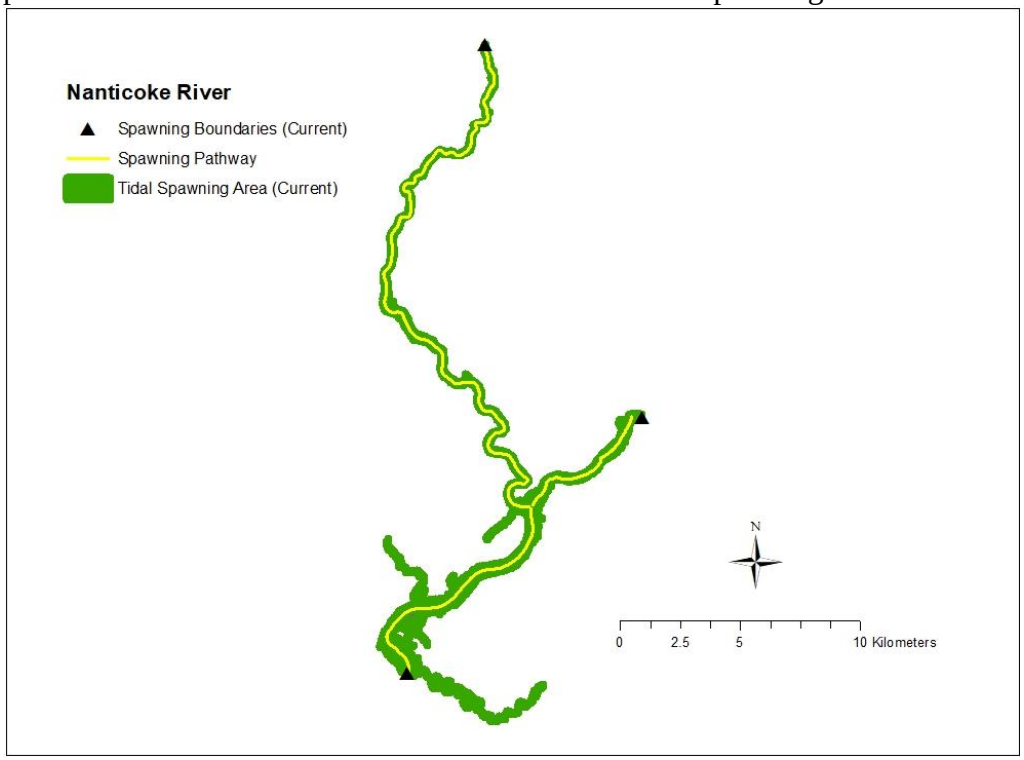


Figure 4. Current and historical Patapsco River American shad spawning reaches. The spawning pathway represents the path used for river km habitat estimates.

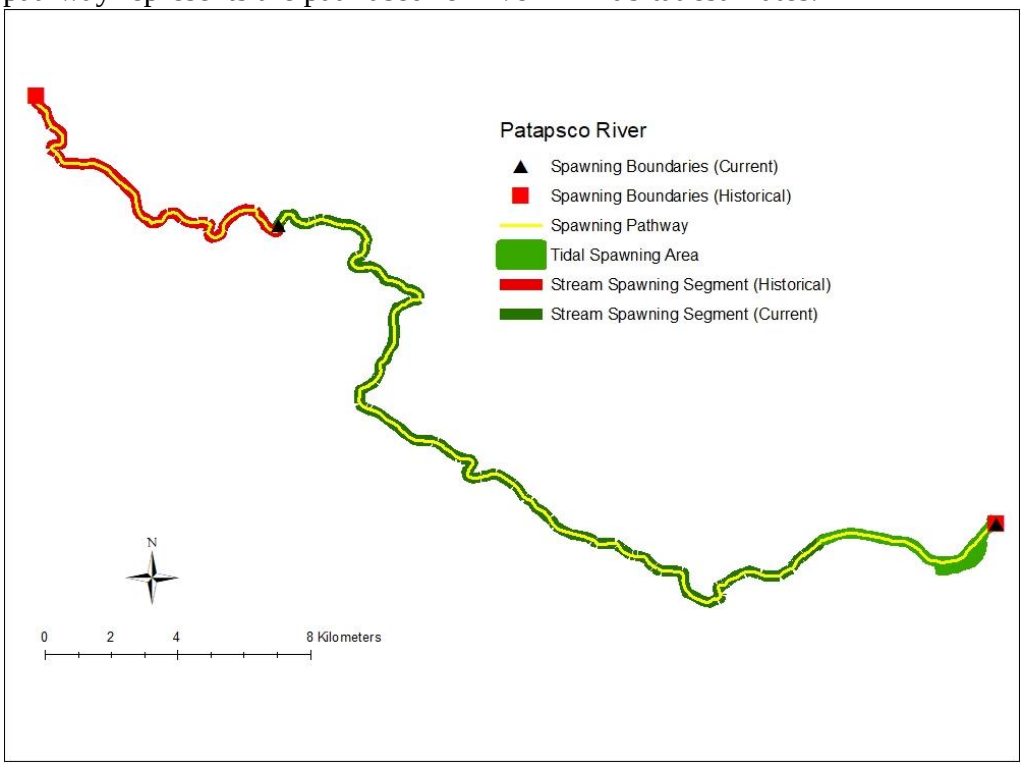


Figure 5. Patuxent River American shad spawning reach. The spawning pathway represents the path used for river km habitat estimates. All historical spawning habitat is currently accessible.

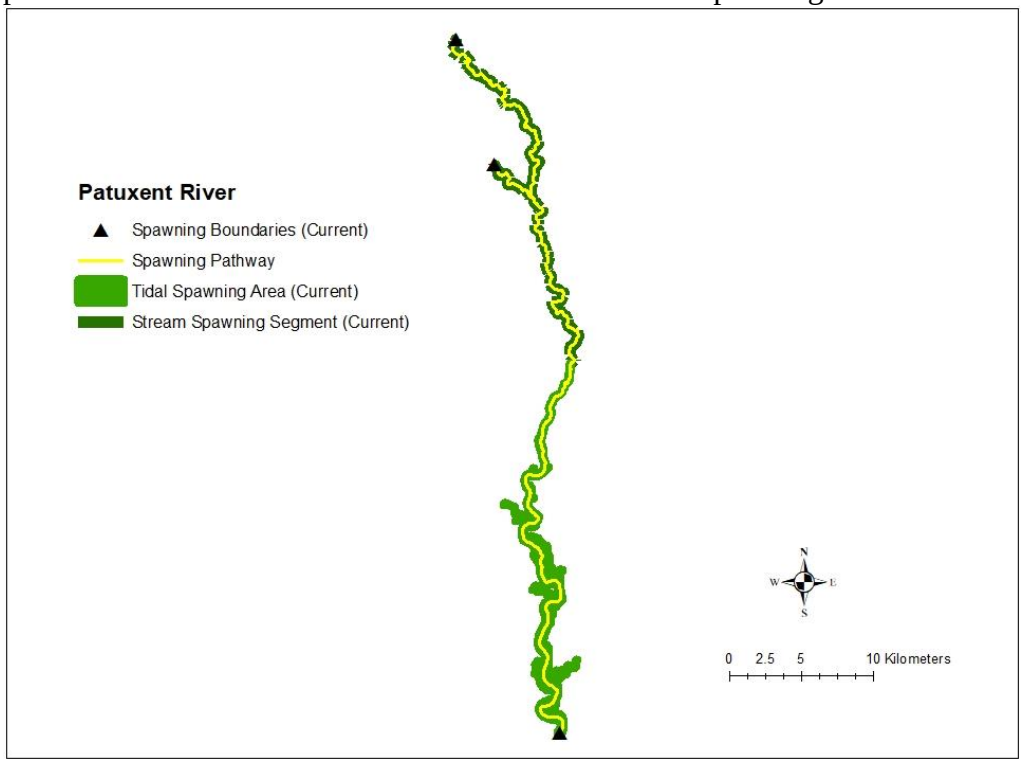


Figure 6. Pocomoke River American shad spawning reach. The spawning pathway represents the path used for river km habitat estimates. All historical spawning habitat is currently accessible.

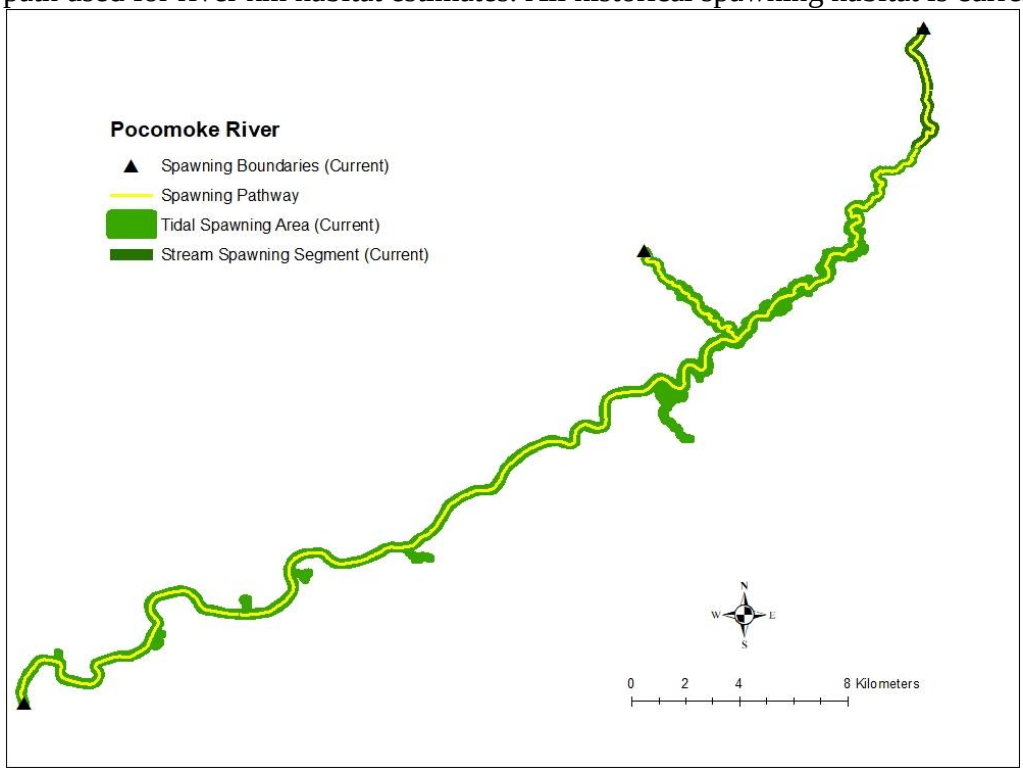


Figure 7. Upper Chesapeake Bay American shad spawning areas. The spawning pathway represents the path used for river km habitat estimates. All historical spawning habitat is currently accessible, though Conowingo Dam presents a significant barrier.

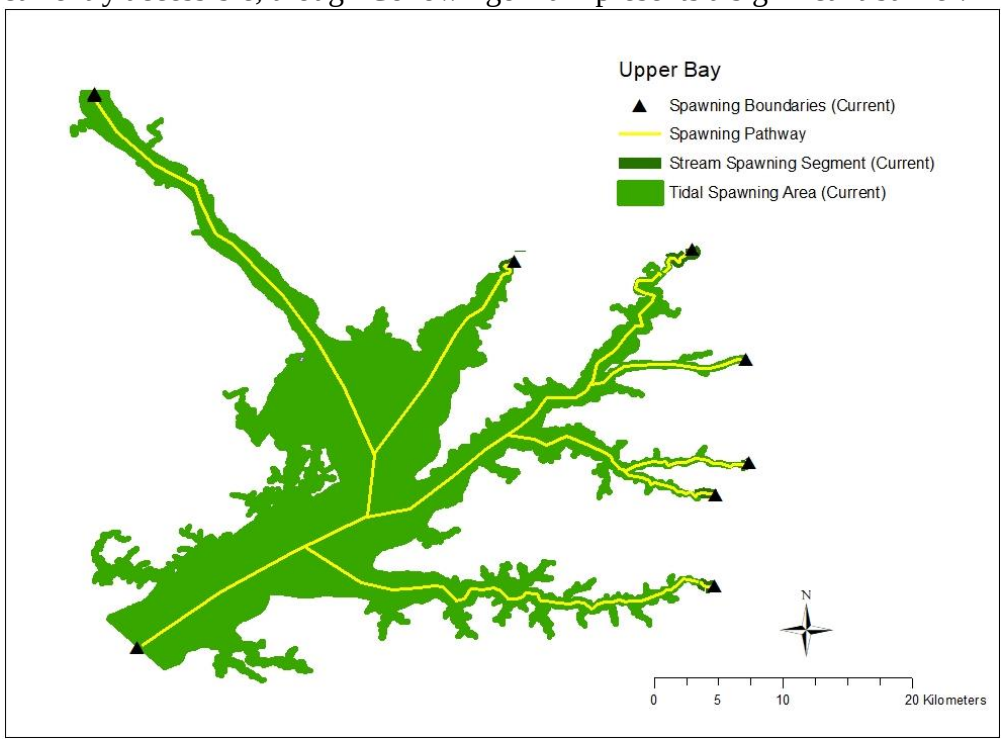


Figure 8. Preferred Upper Chesapeake Bay American shad spawning areas. The spawning pathway represents the path used for river km habitat estimates. All historical spawning habitat is currently accessible, though Conowingo dam presents a significant barrier.

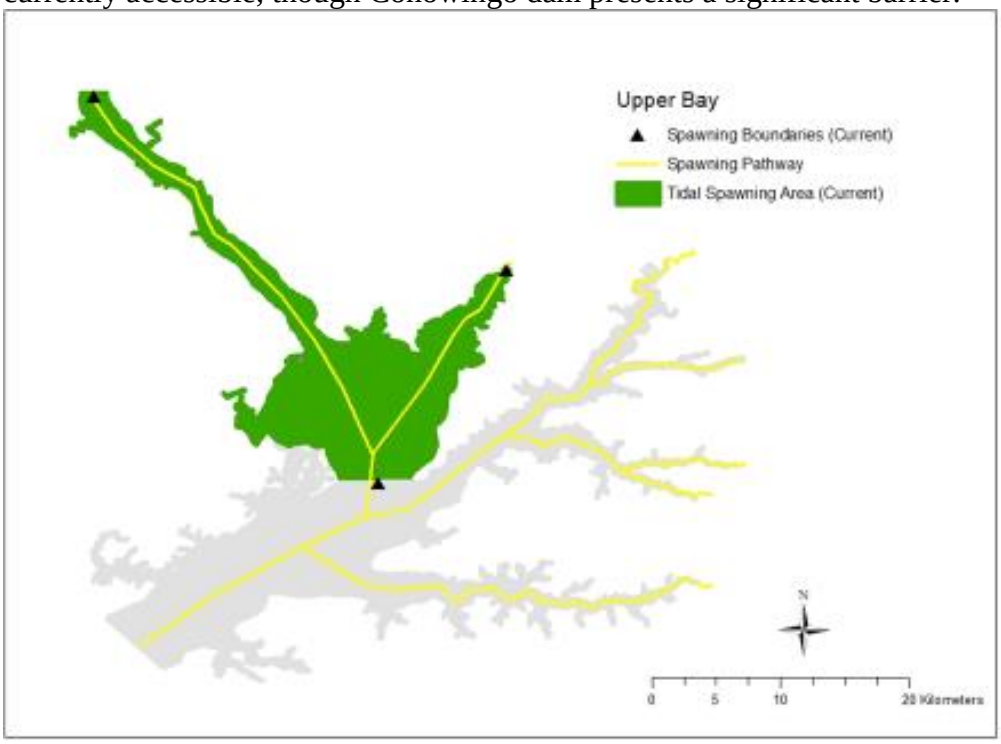


Figure 9. Current and historical Wicomico River American shad spawning reaches. The spawning pathway represents the path used for river km habitat estimates.

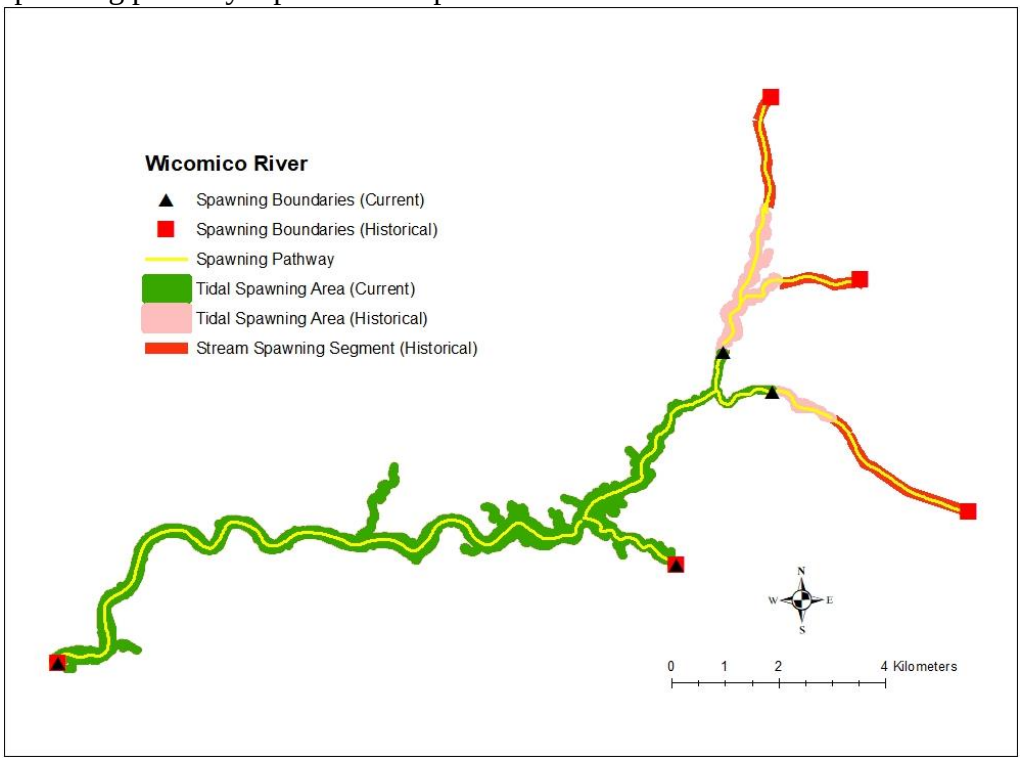


Figure 10. American shad rearing habitat in select Maryland rivers. Rearing habitat favorability was assigned according to average bottom salinity: Preferred (0-4 ppt), Acceptable (4-7 ppt), or Marginal (7-13 ppt). Rearing habitat lines represent the path used for river kilometer habitat estimates. Barriers restricting access to historic habitat are present on the Patapsco and Wicomico Rivers.

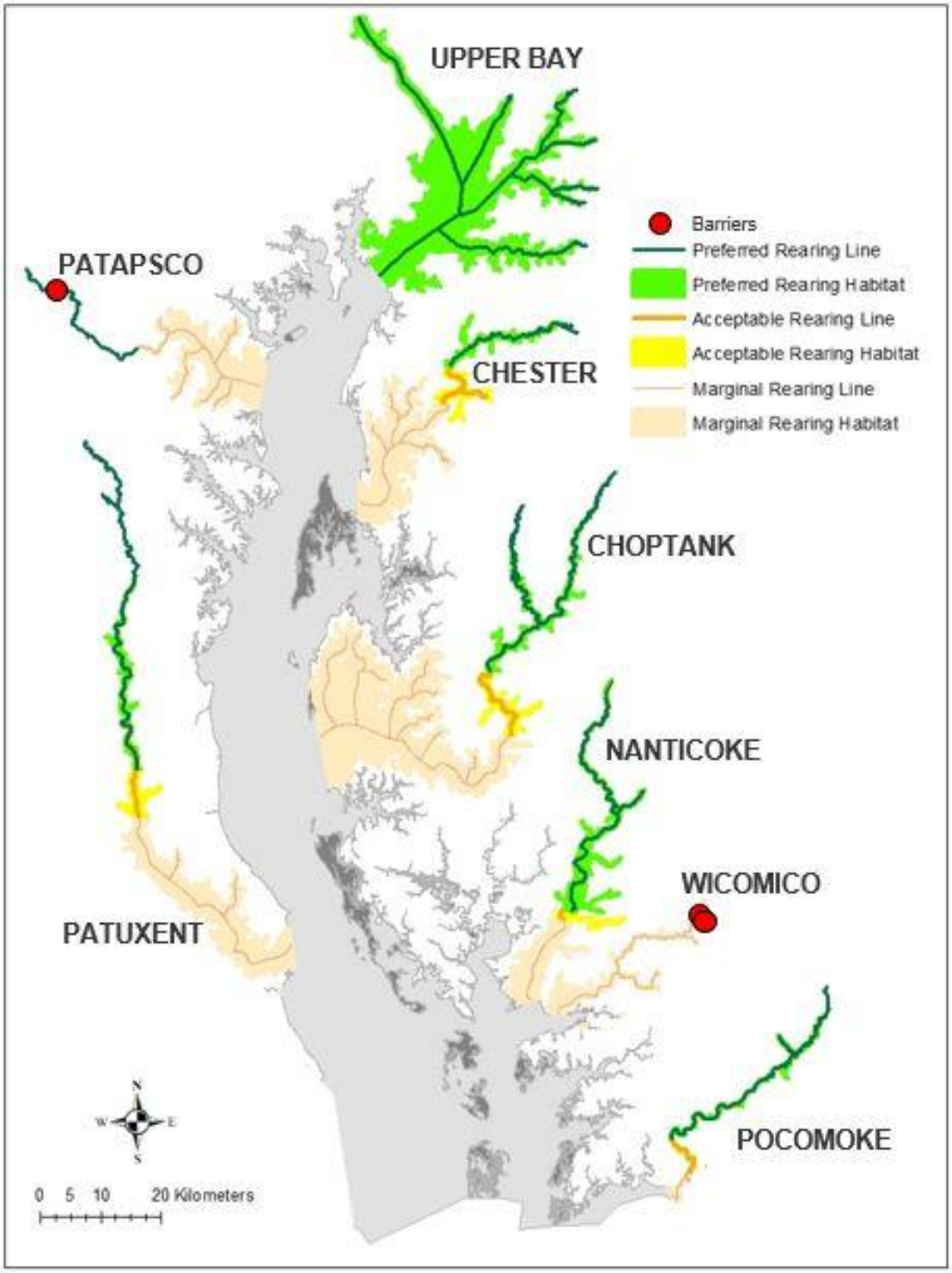
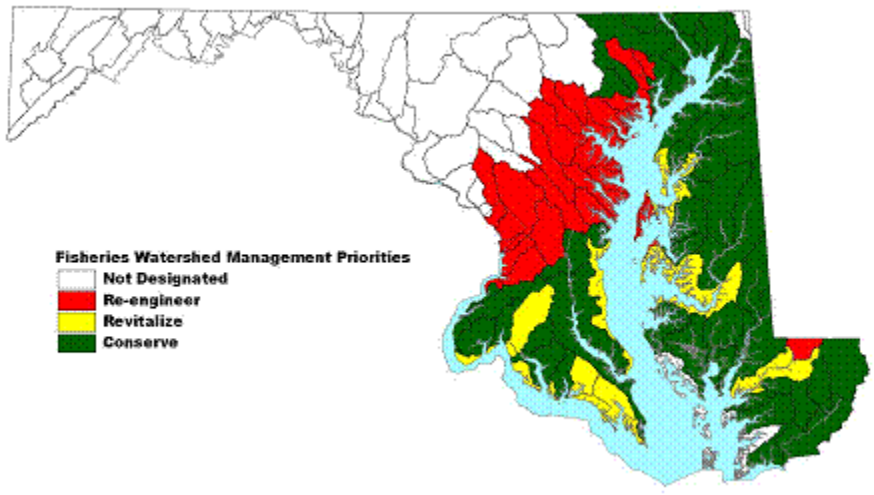


Figure 11. Fisheries watershed management priorities in Maryland. *Conserve* - areas with less than 5% impervious surface; recommend harvest restrictions and stocking for effective fisheries management and watershed conservation for sound land management. *Revitalize* – areas with 5-10% impervious surface; recommend options to decrease harvest and increase stocking to compensate for effective fishery management, and conserve and revitalize watershed for sound land management. *Re-engineer* – areas with 10-15% impervious surface; fisheries are highly variable; traditional fishery management tools not reliable. Recommend conserving and reconstructing degraded watershed for land management.



Acronyms:

- MDNR: Maryland Department of Natural Resources
- MDE: Maryland Department of the Environment
- MDOT: Maryland Department of Transportation
- MPA: Maryland Port Authority
- FHEP: MDNR Fisheries Habitat and Ecosystem Program
- PPRP: MDNR Power Plant Research Program
- FPP: MDNR Fish Passage Program
- MCCC: Maryland Commission on Climate Change
- MDA: Maryland Department of Agriculture
- USFWS: United States Fish and Wildlife Service
- FERC: Federal Energy Regulatory Committee
- SRAFRC: Susquehanna River Anadromous Fish Restoration Cooperative
- ASMFC: Atlantic States Marine Fisheries Commission
- NMFS: National Marine Fisheries Service
- MAFMC: Mid Atlantic Fisheries Management Council
- NOAA: National Oceanographic and Atmospheric Administration
- NFWF: National Fish and Wildlife Foundation
- NDPES: National Pollutant Discharge Elimination System
- EPA: Environmental Protection Agency
- FDA: Food and Drug Administration
- USDA: United States Department of Agriculture
- PFBC: Pennsylvania Fish and Boat Commission
- PADEP: Pennsylvania Department of Environmental Protection
- SRBC: Susquehanna River Basin Commission
- NYDEC: New York Department of Environmental Conservation
- CBP: Chesapeake Bay Program
- EBTJV: Eastern Brook Trout Joint Venture
- EFL: Conowingo East Fish Lift
- WFL: Conowingo West Fish Lift
- PAHs: Polycyclic Aromatic Hydrocarbons
- DO: Dissolved Oxygen
- TMDL: Total Maximum Daily Load

NORTH CAROLINA AMERICAN SHAD HABITAT PLAN

North Carolina Division of Marine Fisheries
North Carolina Wildlife Resources Commission

January 2021

Introduction

Amendment 3 to the Atlantic States Marine Fisheries Commission (ASMFC) Interstate Fishery Management Plan required all states and jurisdictions to develop an Implementation Plan, which consists of two components: 1) a Sustainable Fishery Plan (for jurisdictions wishing to keep fisheries open) and 2) a Habitat Plan. The requirement for a Habitat Plan was in recognition of the fact that much of the decline in American shad stocks along the Atlantic coast is related to degradation of spawning and juvenile habitat from anthropogenic impacts such as upland development, stormwater runoff, and sewer discharges, as well as barriers to migration from dam construction and culverts. Restoration, protection, and enhancement of American shad habitat is a key component of rebuilding populations of this species to levels that will support their ecological, economic, and cultural roles.

The purpose of the Habitat Plan is to collate information regarding the status of and threats to American shad spawning, nursery, and juvenile habitats specific to a particular state or jurisdiction, and to develop restoration programs to address such threats. This document serves as North Carolina's American Shad Habitat Plan and as detailed below, draws heavily upon existing documents and efforts.

North Carolina Coastal Habitat Protection Plan (CHPP)

In recognition of the fact that protecting habitat was equally as important as preventing overfishing, the North Carolina General Assembly passed the Fisheries Reform Act in 1997. This law established the requirement to develop a Coastal Habitat Protection Plan (CHPP) to protect and enhance important coastal fisheries habitats. It also contains a directive to three major rulemaking commissions (Environmental Management, Coastal Resources and Marine Fisheries) to cooperate in the development and implementation of the plan. The NC Division of Marine Fisheries (NCDMF) and the Albemarle-Pamlico National Estuary Partnership (APNEP) were charged with writing the plan and serve as lead agencies within the NC Department of Environmental Quality (NCDEQ).

The initial version of the CHPP, approved by all three commissions in December 2004, detailed the status, trends and threats to six major fisheries habitats: the water column, submerged aquatic vegetation, wetlands, shell bottom, soft bottom and ocean hard bottom (Street et al 2005). The CHPP is reviewed and updated on a five-year schedule. The first review of the CHPP began in 2009, and the updated plan was published in 2010 (Deaton et al 2010). The last update was completed in 2016 (NCDEQ 2016) and the 2021 update is currently underway. Similar to the previous versions, the 2016 CHPP includes four overarching goals for protection of coastal fish habitat.

1) Improve effectiveness of existing rules and programs protecting coastal fish habitats
2) Identify and delineate strategic coastal habitats
3) Enhance habitat and protect it from physical impacts
4) Enhance and protect water quality

Because of the breadth and depth of data and information contained in the document, both state and federal agency staff have come to rely on the CHPP as a resource. Recommendations from the CHPP have been incorporated into several programs within state government as funding priorities.

To minimize duplication, the NC American Shad Habitat Plan (hereafter "Habitat Plan") relies heavily upon the extensive body of information and recommendations contained within the 2016 CHPP. As such, various sections of the CHPP are referred to in the sections of the Habitat Plan for more detailed and specific information. Because the 2016 CHPP is 475 pages (including appendices), it is not included as an appendix to this Habitat Plan. Individual chapters of the 2016 CHPP as well as the two year Implementation Plans can be found on the CHPP website (http://portal.ncdenr.org/web/mf/habitat/chpp/07-2020-chpp), and all documents related to Strategic Habitat Areas (referred to in the Habitat Assessment below) can be found on the Strategic Habitat Areas website (http://portal.ncdenr.org/web/mf/habitat/SHAs).

Previous versions of the CHPP have been accompanied by two year implementation plans. However, to improve efficacy of implementation, the 2021 CHPP update will focus on a five key priority habitat issues.

1. Environmental Rule Compliance to Protect Habitat
2. Habitat Monitoring to Assess Status and Regulatory Effectiveness
3. Submerged Aquatic Vegetation Protection and Restoration, with Focus on Water Quality Improvements
4. Wetland Protection and Enhancement, with Focus on Nature-Based Methods
5. Reducing Inflow and Infiltration associated with Wastewater Infrastructure to Improve Coastal Water Quality

Objectives and recommendations will be restructured to be actionable, with a focus on policy and rule development as needed. Non-regulatory measures can also be highly effective, given enough staff and monetary resources. Because the source document is comprehensive and remains relevant, it will be selectively updated as needed to support priority issues.

The Habitat Plan follows the suggested outline contained in Amendment 3, consisting of a Habitat Assessment, Threats Assessment, and Habitat Restoration Program.

Section 1: Habitat Assessment

American Shad Spawning and Nursery Area Habitat

American shad are an anadromous, pelagic, highly migratory schooling species (Colette and Klein-MacPhee 2002). They utilize a variety of habitats with variations in habitat preference due to location, season, and ontogenetic stage.

American shad are found in most habitats identified by the CHPP including water column, wetlands, submerged aquatic vegetation (SAV), soft bottom, hard bottom, and shell bottom. Each habitat is part of a larger habitat mosaic, which plays a vital role in the overall productivity and health of the coastal ecosystem. Although American shad are found in all of these habitats, the usage varies by habitat. Additionally, these habitats provide the appropriate physicochemical and biological conditions necessary to maintain and enhance the American shad population. Limburg and Waldman (2009) have shown that the loss of habitat contributes to the decline in anadromous fish stocks throughout the world. Therefore, the protection of each habitat type is critical to the sustainability of the American shad stock.

American shad ascend most coastal rivers in North Carolina (Figure 1). American shad are most abundant in the Roanoke, Chowan, Tar-Pamlico, Neuse, Northeast Cape Fear, and Cape Fear rivers as well as Albemarle and Pamlico sounds (Street *et al*. 1975; Marshall 1976a;

Sholar 1977; Fischer 1980; Hawkins 1980a; Hawkins 1980b; Johnson *et al*. 1981; Winslow *et al*. 1983; Winslow *et al*. 1985).

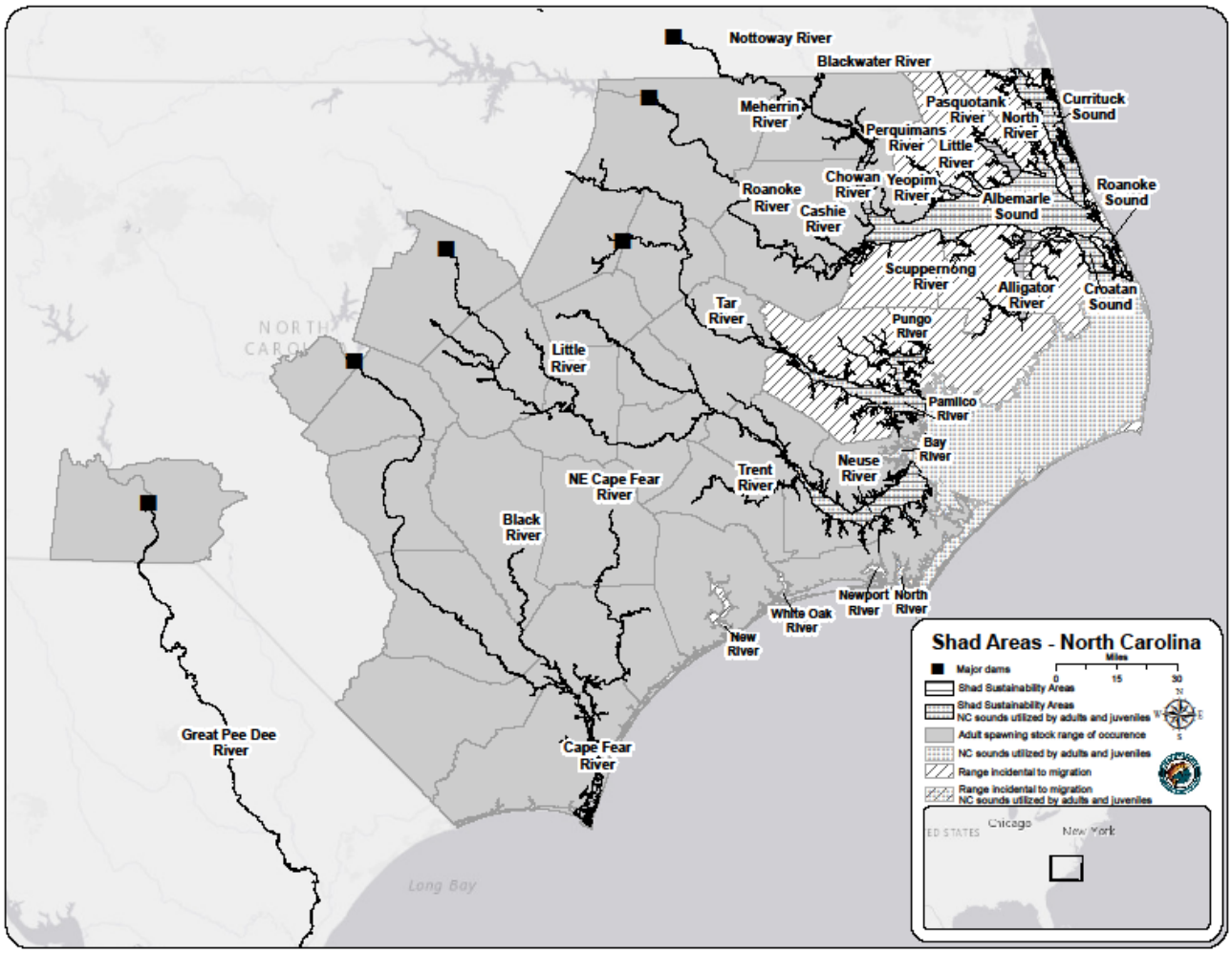


Figure 1. North Carolina river systems depicting the extent of American shad occurrence and habitat use.

The NCDMF conducted American shad spawning area surveys between 1973 and 1984 in the major coastal tributaries. Physical characteristics of the spawning grounds vary somewhat between systems. Shad may spawn anywhere within a given spawning area but prefer shallow flats composed of sand, gravel, or a combination of the two bordering the rivers (Smith 1907; Walburg and Nichols 1967; Beasley and Hightower 2000; Hightower and Sparks 2003). Water conditions may vary from clear to very turbid, water depth ranges from 3 to 30 ft, and temperatures may range from 8 to 26°C (Walburg and Nichols 1967; Winslow 1990).
Shad eggs are non-adhesive and slightly heavier than water, so they gradually sink and are carried along by currents (Ulrich *et al*. 1979). Sufficient water current is required to keep eggs suspended in the water column for successful development (Cheek 1968; Sholar 1977). Current velocity, increasing light and temperature are all important cues for anadromous spawning activity (Klauda et al. 1991; Orth and White 1993). Successful spawning of American shad coincides with water velocities between 2 and 3 ft/s (61-91 cm/s) (Fay et al. 1983; Mackenzie et

al. 1985; Hill et al. 1989). This requirement may explain why American shad spawning was found only in the Nottoway, Blackwater, Meherrin, Roanoke, Tar, Neuse and Cape Fear rivers, all of which have relatively strong currents compared to other coastal rivers in the state. During their spawning migration, anadromous fish actively avoid waters with low dissolved oxygen and extremely high turbidity (Steel 1991). All American shad spawning areas have been documented either by capture of eggs or larvae, or direct observation of spawning.

Nursery habitat for anadromous fishes is generally downstream from spawning locations but still within the freshwater low-salinity system. Juvenile American shad use the same general nursery areas as river herring, but the young shad prefer deeper pools away from the shoreline and occasionally move into shallow riffles (Funderburk et al. 1991). During summer, juvenile shad migrate from the bottom during the day to the surface at night (Loesch and Kriete 1984). A decrease in temperature during the fall and slight increases in river flow seem to trigger downstream movement of American shad (Funderburk et al. 1991). Nursery area surveys conducted by NCDMF noted decreased catch of juvenile shad in October on the Cape Fear River, Neuse River, and Albemarle Sound (Winslow 1990).

Albemarle Sound

The Albemarle Sound area includes Albemarle Sound, all of its tributaries, Currituck, Roanoke, and Croatan sounds, and all of their tributaries. The Albemarle Sound, including the tributaries, occupies more than 212,055 hectares (ha) of open water as well as extensive bordering swamps in northeastern North Carolina (Figure 1). The Albemarle Sound measures 88.5 km long by 4.8 to 22.5 kilometers (km) wide. Shoals generally extend 0.8 km from shore, sloping to a central basin 5.5 to 7.6 meters (m) depth. The bottom consists mostly of sand in the central basin with some mud and detritus on the shoals. The shoreline in eastern Albemarle Sound consists mostly of cypress swamps and a few small beaches, while beaches and low bluffs become more frequent to the west (Street *et al.* 1975). Croatan and Roanoke sounds are estuarine with salinities ranging from 1 part per thousand (ppt) to 28 ppt, depending on tide, wind, and rainfall. Salinities of 2 to 4 ppt sometimes occurred in eastern Albemarle Sound, while salinities of 1 to 2 ppt were occasionally recorded from the downstream portions of the North, Pasquotank, Alligator, and Little Rivers. North, Pasquotank, and Alligator Rivers and eastern Albemarle Sound serve as channels of the Atlantic Intracoastal Waterway (Street *et al.* 1975).

Currituck Sound joins the Albemarle Sound from the northeast, and Croatan and Roanoke sounds join from the southeast. Ten rivers drain into Albemarle Sound, which joins Pamlico Sound through Croatan and Roanoke sounds, and in turn, empties into the Atlantic Ocean via Oregon Inlet. Most of the rivers originate in coastal swamps and do not function as spawning areas for American shad. Moving across the Albemarle Sound drainage rivers from east to west, the North River joins the Albemarle Sound from the northeast. The North River originates in coastal swamps and occupies about 6,475 ha and is about 34 km in length (Baker and Smith 1965, as cited by Street *et al.* 1975, p. 7). The Pasquotank River, covering about 13,468 ha, is the main southern outlet for the Great Dismal Swamp, and is about 64 km in length (Baker and Smith 1965, as cited by Street *et al.* 1975, p. 7). The Little River originates in the Great Dismal Swamp, occupies about 2,849 ha, and flows approximately 30.6 km south to the Albemarle Sound (Baker and Smith 1965, as cited by Street *et al.* 1975, p. 8). The Perquimans River also originates in the Great Dismal Swamp and flows approximately 50 km to the Albemarle Sound and occupies about 5,180 ha (Baker and Smith 1965, as cited by Street *et al.* 1975, p. 8). The Yeopim River (including Yeopim Creek) originates in local swamps and is about 16 km long and occupies approximately 1,554 ha (Baker and Smith 1965, as cited by Street *et al.* 1975, p. 8). The Roanoke and Chowan Rivers are the principal tributaries of the Albemarle Sound, and areas of these rivers are known to function as American shad spawning areas (Street *et al.*

1975; Johnson *et al.* 1981; Winslow *et al*. 1983; Winslow *et al.* 1985; Hightower and Sparks 2003).

Chowan River
Chowan River occupies approximately 15,540 ha and extends 80.5 km from the North Carolina-Virginia border to the Albemarle Sound. Three rivers drain into the Chowan River: Meherrin, Nottoway, and Blackwater. The Meherrin and Nottoway rivers are the major tributaries of the Chowan and begin in the Piedmont Plateau of Virginia (Smith 1963, as cited by Street *et al.* 1975, p. 8). The Blackwater River, a smaller tributary, originates as a coastal plain swamp in Prince George County, Virginia (VDGIF 2019). All three rivers function as a spawning area for American shad.

Roanoke River (including Cashie River)
The Roanoke River and Cashie River join the Albemarle Sound from the west, via a shared delta. The Cashie River originates in local swamps, occupies approximately 777 ha, and flows 48.3 km to enter the Albemarle Sound (Carnes 1965, as cited by Street *et al.* 1975, p. 8). The Roanoke River flows 220.5 km from the Roanoke Rapids Dam (Roanoke Rapids, North Carolina) to the Albemarle Sound. The river begins in the foothills of Virginia's Blue Ridge Mountains and crosses the Fall Line just below Roanoke Rapids Dam (Carnes 1965, as cited by Street *et al.* 1975, p. 9). Near the North Carolina-Virginia border, John H. Kerr Reservoir, Lake Gaston, and Roanoke Rapids Lake impound the Roanoke River. The U.S. Army Corps of Engineers (USACE) and Dominion Energy operate these reservoirs for flood control and hydropower generation. A dam was constructed in 1955 on the River at Roanoke Rapids, North Carolina, 220.6 km (137 miles) from the mouth (Carnes 1965). This dam does not have facilities for fish passage and is therefore the upper limit of migration. Recent studies have shown that American shad accumulate in the Roanoke Rapids, NC and Weldon, NC areas, and newly-spawned American shad eggs have been collected there (Knutzen 1997; Hightower and Sparks 2003; Kornegay and Thomas 2004; Harris and Hightower 2007). Downstream of Roanoke Rapids Lake, flows in the Roanoke River are highly regulated by discharges from the dams. From the Roanoke Rapids Dam, the Roanoke River flows 221 km (137 miles) through an expansive area of bottomland hardwood wetlands to its confluence with Albemarle Sound. Major tributaries of this lower section of the Roanoke River include Broad Creek, Devil's Gut, Broad Neck Swamp, Conoho Neck Swamp, and the Cashie River.

Tar-Pamlico River
The Tar-Pamlico watershed is the fourth largest in North Carolina encompassing 14,090 square km (5,440 square miles). From its headwaters in Person County, the Tar-Pamlico watershed is drained by 3,790 km (2,355 miles) of tributaries along its 290 km (180 mile) main-channel length to Pamlico Sound near the confluence of the Pungo River (NCDWQ 1999; Figure 1). The river reach upstream of the City of Washington is designated as the Tar River and is primarily freshwater, while the reach below Washington, referred to as the Pamlico River, has characteristics of an upper estuary. Sixteen counties and six large municipalities (Greenville, Henderson, Oxford, Rocky Mount, Tarboro, and Washington) are represented within the basin. Major tributaries to the river include Fishing, Swift, and Tranters creeks, Cokey Swamp, and the Pungo River. Main stem headwater reaches, and tributaries are located within the outer piedmont physiographic region and are characterized by low flows during dry seasons due to minimal groundwater discharge (NCDWQ 1999). However, since the majority of the basin is located within the coastal plain, these waters are largely characterized by slow flowing, low gradient, brown and blackwater streams with extensive floodplains often comprised of bottomland hardwood forests and marshes.

From its headwaters in the North Carolina Piedmont the Tar River flows 288 km in a southeasterly direction before emptying into the Pamlico River at sea level. The Tar River drainage basin is approximately 802,893 ha. The principal tributaries of the Tar River, as it is ascended, are Tranters Creek, Town Creek, Fishing Creek, and Swift Creek. The Pamlico River is actually a continuation of the Tar River with the name change occurring at the US 17 bridge near Washington, North Carolina. It flows southeasterly about 53 km and empties into the Pamlico Sound about 51 km west of Ocracoke Inlet. The Pamlico River drainage basin is approximately 315,967 ha. The principal tributaries of the Pamlico River, in addition to the Tar River, include Pungo River, Rose Bay, Swanquarter Bay, Juniper Bay, Chocowinity Bay, Broad Creek, Bath Creek, Blount Creek, Durham Creek, North Creek, Goose Creek, South Creek, and Upper Goose Creek (Marshall 1976b).

Neuse River

The Neuse River is formed by the confluence of the Eno and Flat Rivers in the Piedmont region of North Carolina and flows in a southeasterly direction through the coastal lowlands discharging into Pamlico Sound 430 km from its origin (Hawkins 1980b; McMahon and Lloyd 1995; Figure 1). It resides entirely in North Carolina and has a drainage area of 1,449,869 ha. of land (Hawkins 1980b; McMahon and Lloyd 1995). The river flows in a southeasterly direction from its origin to below New Bern where it bends to flow in an easterly direction to the Pamlico Sound. Bay River, West Bay, and a portion of the western Pamlico Sound, and Core Sound from Ocracoke Inlet to Drum Inlet are also included in the basin (Marshall 1977).

The Neuse River and its tributaries drain all or a portion of 18 counties. The upper third of the river lies in the Piedmont Region of the state with the fall line occurring halfway between Raleigh and Smithfield, North Carolina. Flow regimes in the Neuse River downstream of Raleigh, North Carolina are regulated by Falls Lake Dam (rkm 370), which was built in 1983 by the USACE to create an impoundment for flood control, water supply, water quality, and recreational purposes. Spawning of American shad has been documented in the main stem Neuse River up to the first dam near Raleigh and in several tributaries: Contentnea Creek, Mill Creek, Little River, Swift Creek, and Crabtree Creek (Burdick and Hightower 2006). Principal tributaries of the Neuse River as it is ascended from its mouth to New Bern are: Broad Creek, Turnagain Bay, South River, Smith and Greens Creek at Oriental, Adams Creek, Dawson Creek, Clubfoot Creek, Hancock Creek, Beards Creek, Slocum Creek, Goose Creek, Upper Broad Creek, and the largest tributary, Trent River. The Trent River is quite large and has an important tributary, Brice Creek. All of these tributaries lie within 55 km of the mouth of the river and are within 93 km of Ocracoke Inlet. Between New Bern and Goldsboro, the principal tributaries are Bachelor Creek, Swift Creek, Cove Creek, and Contentnea Creek. These creeks are all within 103 km of the mouth, and Contentnea Creek at river mile 103 is the last major tributary until Little River is reached near Goldsboro, NC (rkm 261). Further upstream tributaries include: Thoroughfare Swamp, Mill Creek, Black Creek, Swift Creek, Marks Creek, Walnut Creek, Crabtree Creek, Perry Creek, and Smiths Creek. All other tributaries are located upstream of Falls Lake Dam, which represents the uppermost limit of American shad migration in the Neuse River Basin.

Cape Fear River

The Cape Fear River, the largest river system in the state, forms at the confluence of the Deep and Haw rivers in the Piedmont region of North Carolina and flows southeasterly for approximately 274 km to the City of Wilmington and from there, 40 km south to discharge into the Atlantic Ocean at Cape Fear, near Southport, North Carolina (Fischer 1980; Figure 1). The main river drainage area encompasses an area of 15,708 sq km with an additional 7,988 sq km included in the drainage areas of the Deep and Haw Rivers. It is the largest river basin lying completely within the state of North Carolina. The basin includes portions of 27 counties and

114 municipalities, and encompasses 9,984 km of freshwater streams and rivers, 36 lakes and reservoirs, and 15,864 ha of estuarine waters (NCDWQ 1995). The Cape Fear River has five major tributaries: Upper Little River, Lower Little River, Rockfish Creek, Black River, and Northeast Cape Fear River, which is the largest of the tributaries. The major tributaries which feed the Cape Fear River are dark, acidic, swamp-drainage streams; however, the waters of the Cape Fear River itself are usually very turbid (Fischer 1980).

Three navigational dams and locks were built between 1913 and 1934. The dams prevented fish from ascending the river above except during boat lockages or periods of high water. Although the dams were provided with fish ladders, anadromous fishes did not use them (Davis and Cheek 1967, as cited by Fischer 1980) and were prevented from accessing historic spawning habitat around Smiley Falls (rkm 290) and further upstream. However, through an agreement among NC Wildlife Resources Commission (NCWRC), USACE, and US Fish and Wildlife Service, fish are locked upstream through all three locks during the spawning run of anadromous fishes in the spring (Nichols and Louder 1970, as cited by Fischer 1980). In 2012, a rock arch fishway was constructed at the base of Lock and Dam 1 (rkm 97) to provide continuous, volitional fish passage, and USACE halted locking operations for fish passage at Lock and Dam 1 after the fishway was completed. Buckhorn Dam (rkm 316) prevents further migrations to potential upstream spawning habitat except during extreme flood events.

Pee Dee River

The Yadkin-Pee Dee River basin is the second largest basin in North Carolina and covers approximately 7,213 square miles in 21 counties (NCDWQ 2008). The Yadkin River originates in the Blue Ridge Mountains in Caldwell and Wilkes counties and flows through the Piedmont region until being joined by the Uwharrie River to form the Pee Dee River. The Pee Dee River continues its southeast course through North and South Carolina to Winyah Bay at the Atlantic Ocean. Other major tributaries in North Carolina, from downstream to upstream, include the Waccamaw River, Lumber River, and Rocky River. The Yadkin-Pee Dee River is heavily impacted by dams, and the most downstream dam, Blewett Falls Dam (rkm 303), prevents upstream migrations of American Shad. Prior to dam construction in the basin, American Shad were recorded as far upstream as Wilkesboro, NC (rkm 725; Stevenson 1897). Approximately 25 km of American Shad spawning habitat is located in the North Carolina portion of the Pee Dee River downstream of Blewett Falls Dam, while the remaining spawning habitat is in South Carolina. The Yadkin Pee Dee River is not covered in the CHPP because all waters in the North Carolina portion of the basin are designated as inland waters and are not under NCDMF jurisdiction.

Other Coastal Rivers

The North River (Carteret County), Newport River, White Oak River and New River are small coastal rivers located in southeastern North Carolina. These rivers are not presently known as American shad spawning or nursery habitat areas, but historical data has been collected on some (White Oak River and New River) that documents the presence on American shad.

Habitat Designations

There are several different designations used in North Carolina that identify, delineate, and designate functionally important habitat areas. Some of the key designations for anadromous species are nursery areas, anadromous fish spawning areas and strategic habitat areas. These designations are presented below and discussed in the 2016 CHPP.

Nursery areas: Those areas in which for reasons such as food, cover, bottom type, salinity, temperature and other factors, young finfish and crustaceans spend the major portion of their initial growing season [NCMFC rule 15A NCAC 03N .0102 (a)].

Primary nursery area (PNA): Those areas of the estuarine system where initial post-larval development takes place. These areas are located in the uppermost sections of a system where populations are uniformly very early juveniles [NCMFC rule 15A NCAC 03N .0102 (b)].

Secondary nursery areas (SNA): Those areas of the estuarine system where later juvenile development takes place. Populations are usually composed of developing sub-adults of similar size which have migrated from upstream primary nursery areas to the secondary nursery area located in the middle portion of the estuarine system [NCMFC rule 15A NCAC 03N .0102 (c)].

[Inland] primary nursery areas (IPNA): Those [inland] areas inhabited by the embryonic, larval, or juvenile life stages of marine or estuarine fish or crustacean species due to favorable physical, chemical or biological factors [NCWRC rule 15A NCAC 10C.0502].

Anadromous fish spawning areas (AFSA): Those areas where evidence of spawning of anadromous fish has been documented by direct observation of spawning, capture of running ripe females, or capture of eggs or early larvae [NCMFC rule 15A NCAC 03I .0101 (b) (20) (C)].

Anadromous fish nursery areas: Those areas in the riverine and estuarine systems utilized by post-larvae and later juvenile anadromous fish [NCMFC rule 15A NCAC 03I .0101 (b) (20) (D)].

Anadromous Fish Spawning Areas (AFSAs). Anadromous fish spawning areas are defined in NCMFC rule 15A NCAC 03N .0106 and NCWRC rule 15A 10C .0602 as those areas where evidence of spawning of anadromous fish has been documented through direct observation of spawning, capture of running ripe females or capture of eggs or early larvae. The areas are delineated in NCMFC rule 15A NCAC 03R .0115 and NCWRC rule 15A 10C .0603 (Figures 2-5). Anadromous fish spawning areas cover 17% of streams/shorelines and 10% of water bodies in coastal plain portions of CHPP regions. Most AFSAs (70%) are in CHPP Region 1-Albemarle and include the mainstem Roanoke River the Chowan River, and other smaller tributaries.

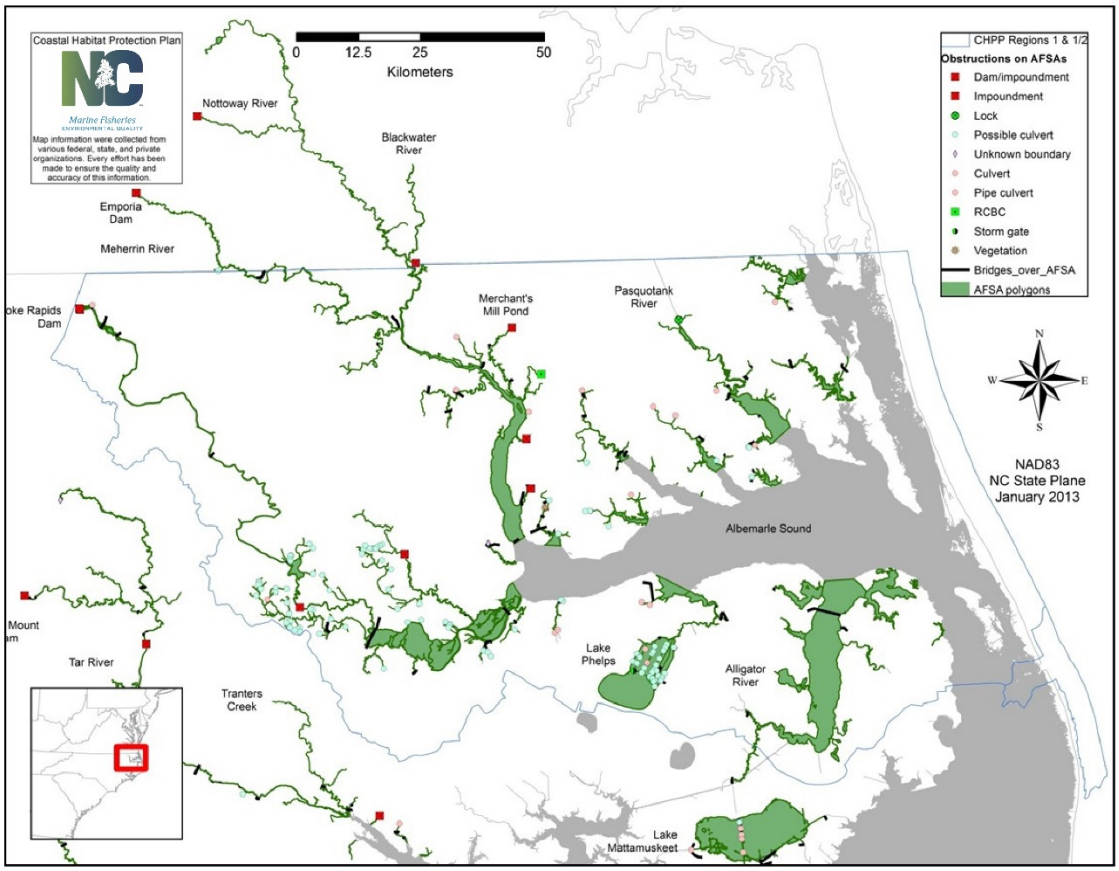


Figure 2. Anadromous fish spawning areas for CHPP Region 1-Albemarle (Albemarle, Currituck, and Roanoke sounds) and Region 1/2 (Oregon Inlet).

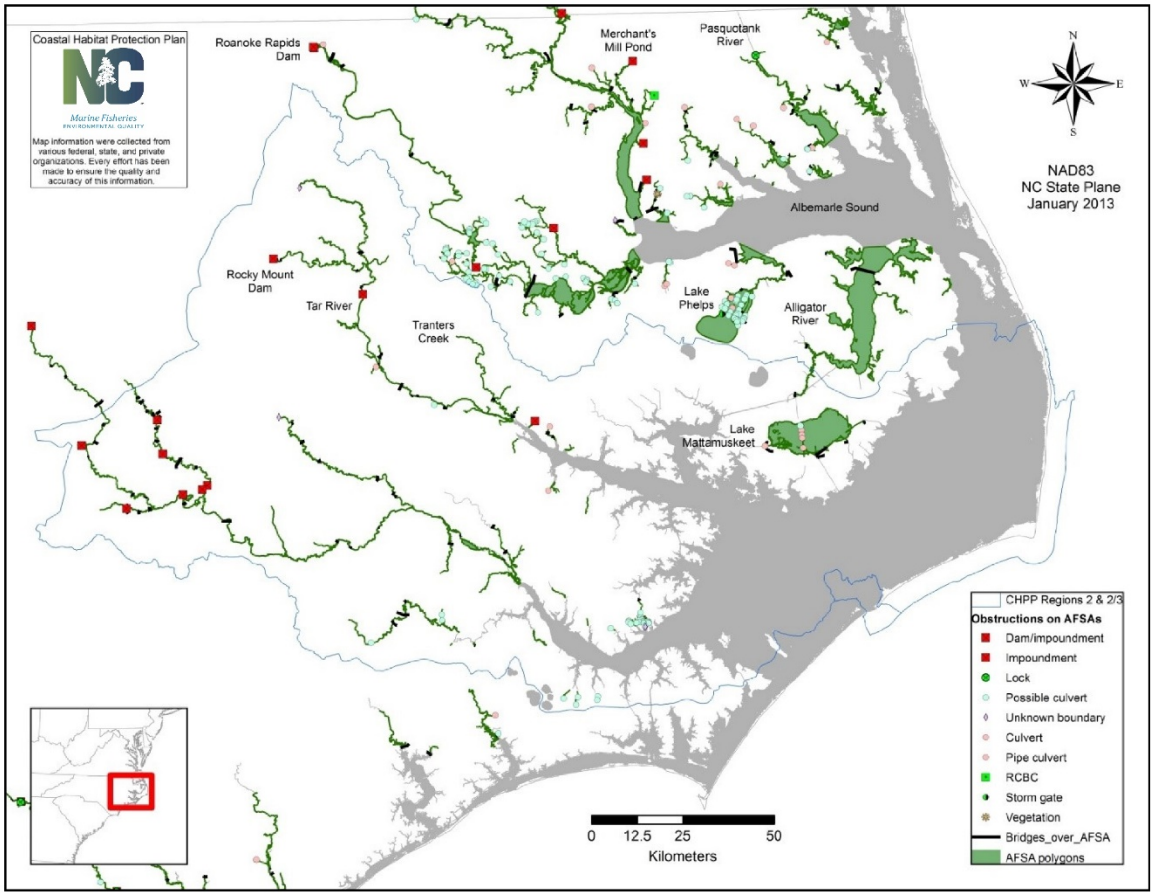


Figure 3. Anadromous fish spawning areas for CHPP Region 2-Pamlico (Pamlico Sound; Neuse and Tar-Pamlico rivers) and Region 2/3 (Ocracoke Inlet).

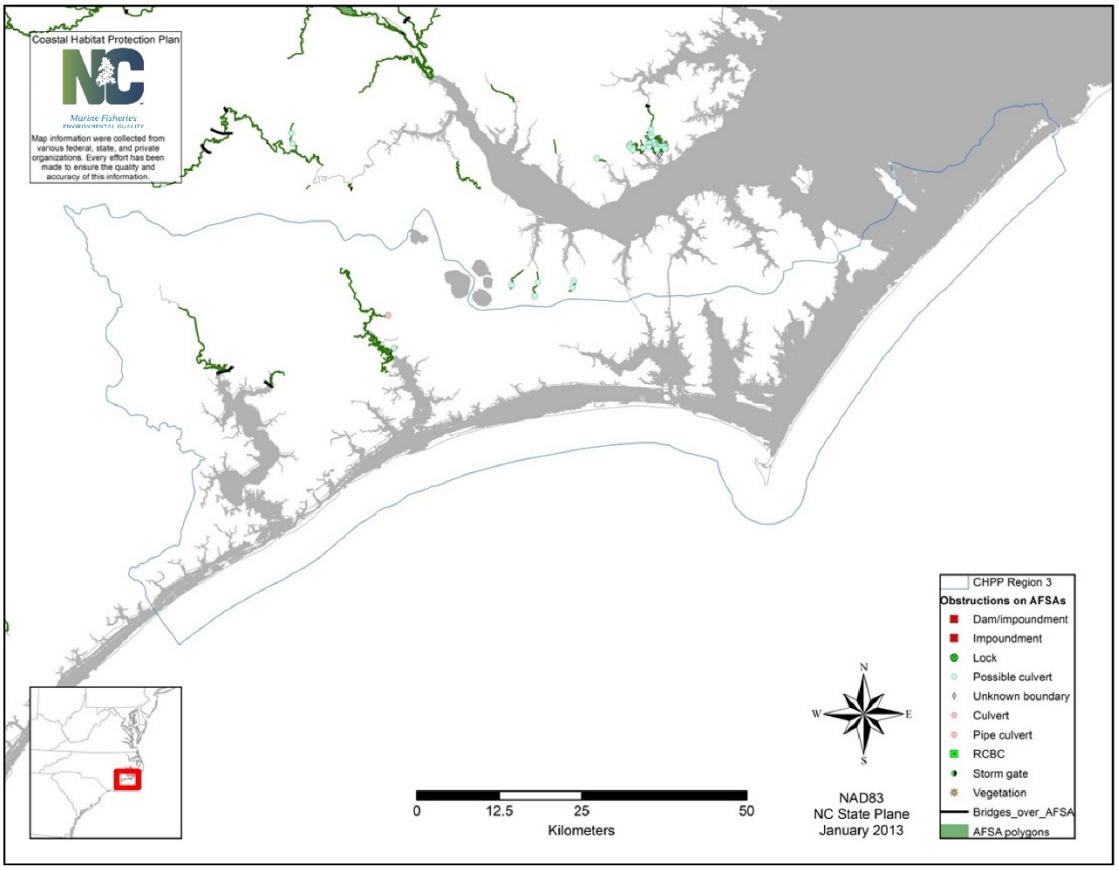


Figure 4. Anadromous fish spawning areas for CHPP Region 3-Core-Bogue (Core, Bogue, Stump Sounds; New and White Oak Rivers)

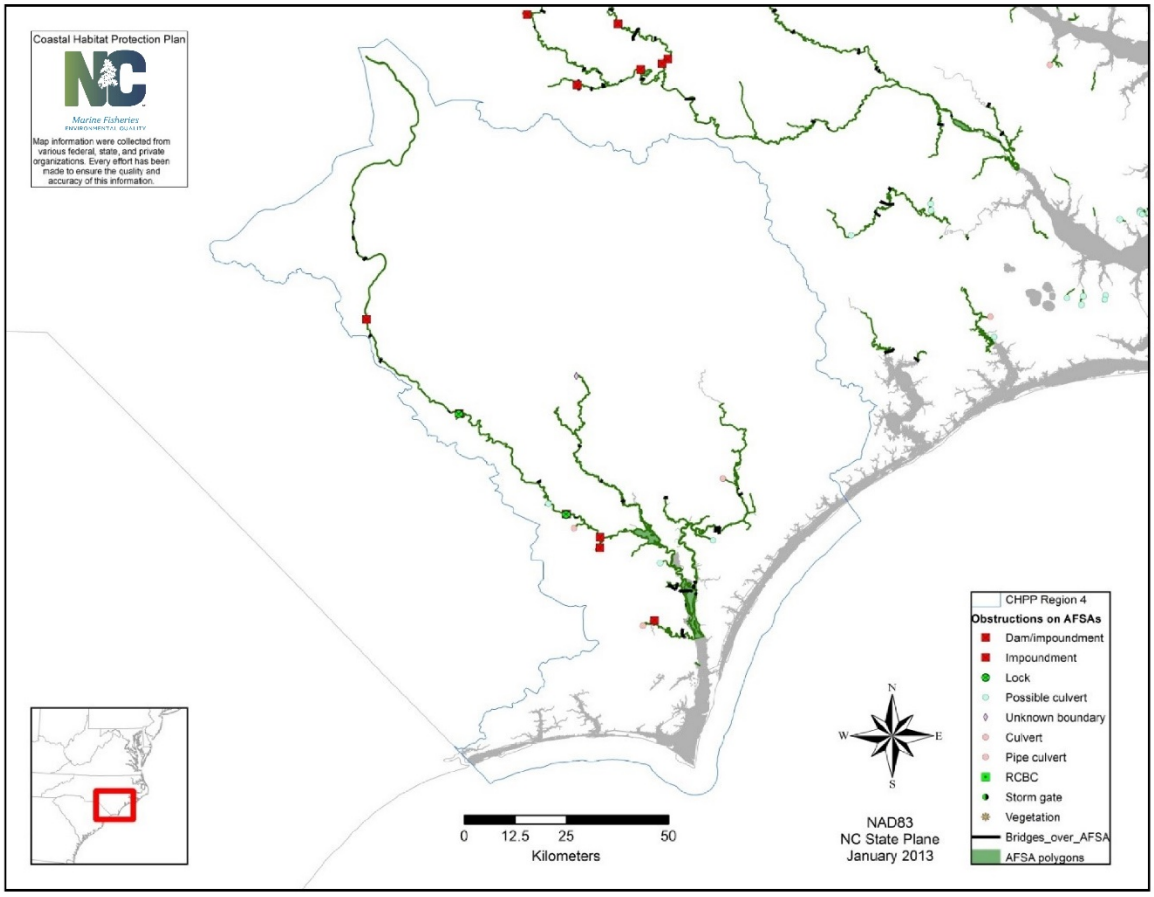


Figure 5. Anadromous fish spawning areas for CHPP Region 4-Cape Fear (Cape Fear River; tidal creeks and sounds, Northeast Cape Fear River, and Black River).

Nursery Areas

North Carolina Primary Nursery Areas, first designated by the NC Marine Fisheries Commission (NCMFC) in 1977, are similar in concept to Federal Habitat Areas of Particular Concern (HPAC). The NCMFC and NCWRC have designated tens of thousands of acres as nursery areas in North Carolina (see below). The state designations are well accepted by the various state and federal regulatory and permitting agencies, as well as by the public.

The NCMFC and NCWRC have designated nursery areas since 1977 and 1990, respectively, based on field sampling (Figures 6 and 7). Approximately 162,000 acres of Coastal Fishing Waters are currently designated by the NCMFC as Primary, Secondary, and Special Secondary Nursery Areas. About 10,000 acres of Inland Fishing Waters in the coastal area are designated as Inland Primary Nursery Areas (IPNA), as well as the following areas of the four main rivers draining to North Carolina's coast:

- Roanoke River, U.S. 258 bridge to Roanoke Rapids Dam (35.5 stream miles, 57.1 km)
- Tar-Pamlico River, railroad bridge at Washington to Rocky Mount Mill Dam (90.2 stream miles, 145.2 km)
- Neuse River, Pitchkettle Creek to Milburnie Dam (160.6 stream miles, 258.4 km)
- Cape Fear River, Lock and Dam #1 to Buckhorn Dam (126.7 stream miles, 203.9 km).

There are specific protections for designated nursery areas included in the rules of the NC

Environmental Management, Coastal Resources and Marine Fisheries commissions. There are relatively few primary nursery areas (PNA) in the Albemarle/Roanoke region, but a relatively large number of IPNAs. There are approximately 162,000 acres of PNA and secondary nursery area (SNA) in North Carolina Coastal Fishing Waters (including both water and wetlands).

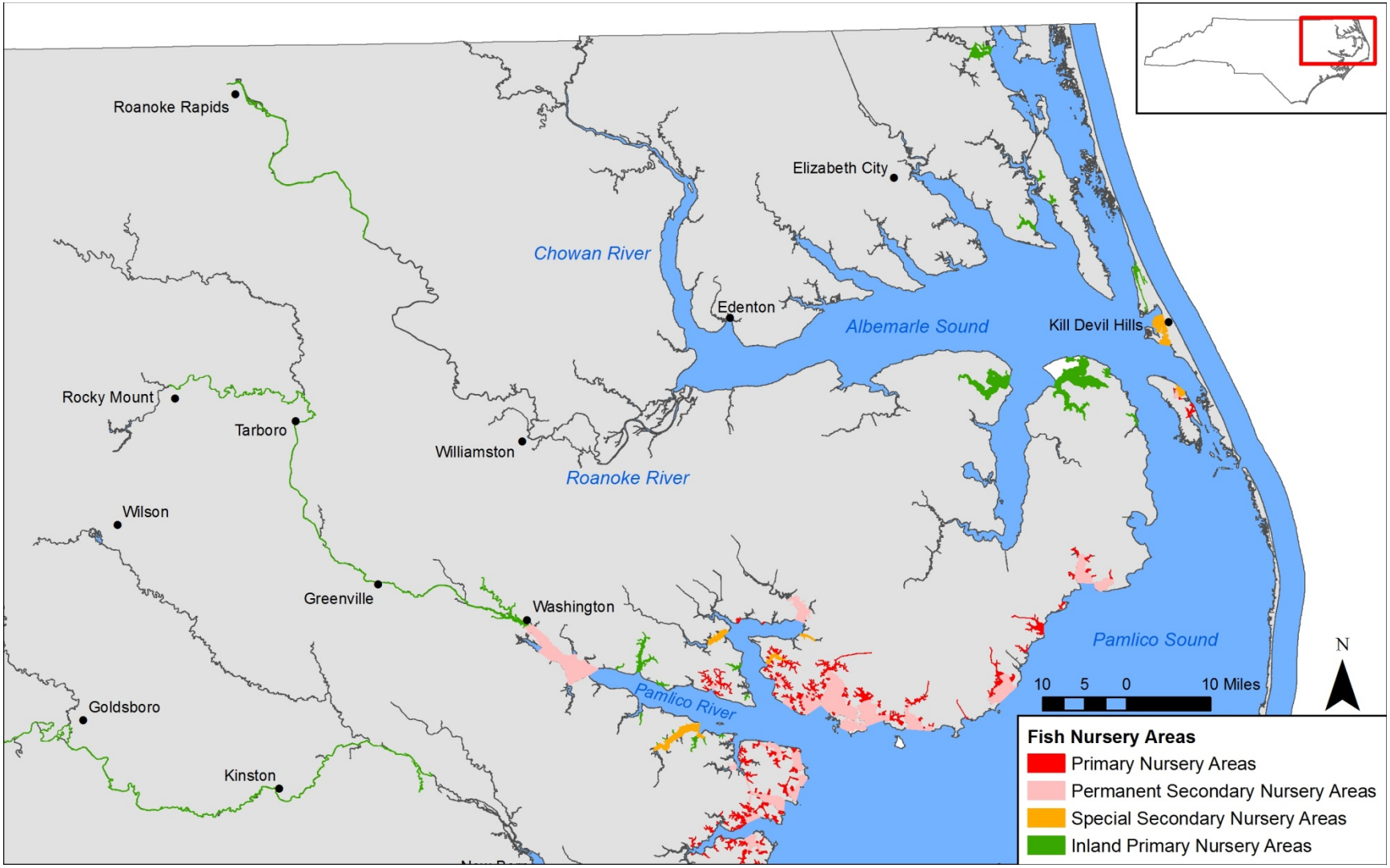


Figure 6. Nursery area designations in the Albemarle Sound and Tar-Pamlico River areas.

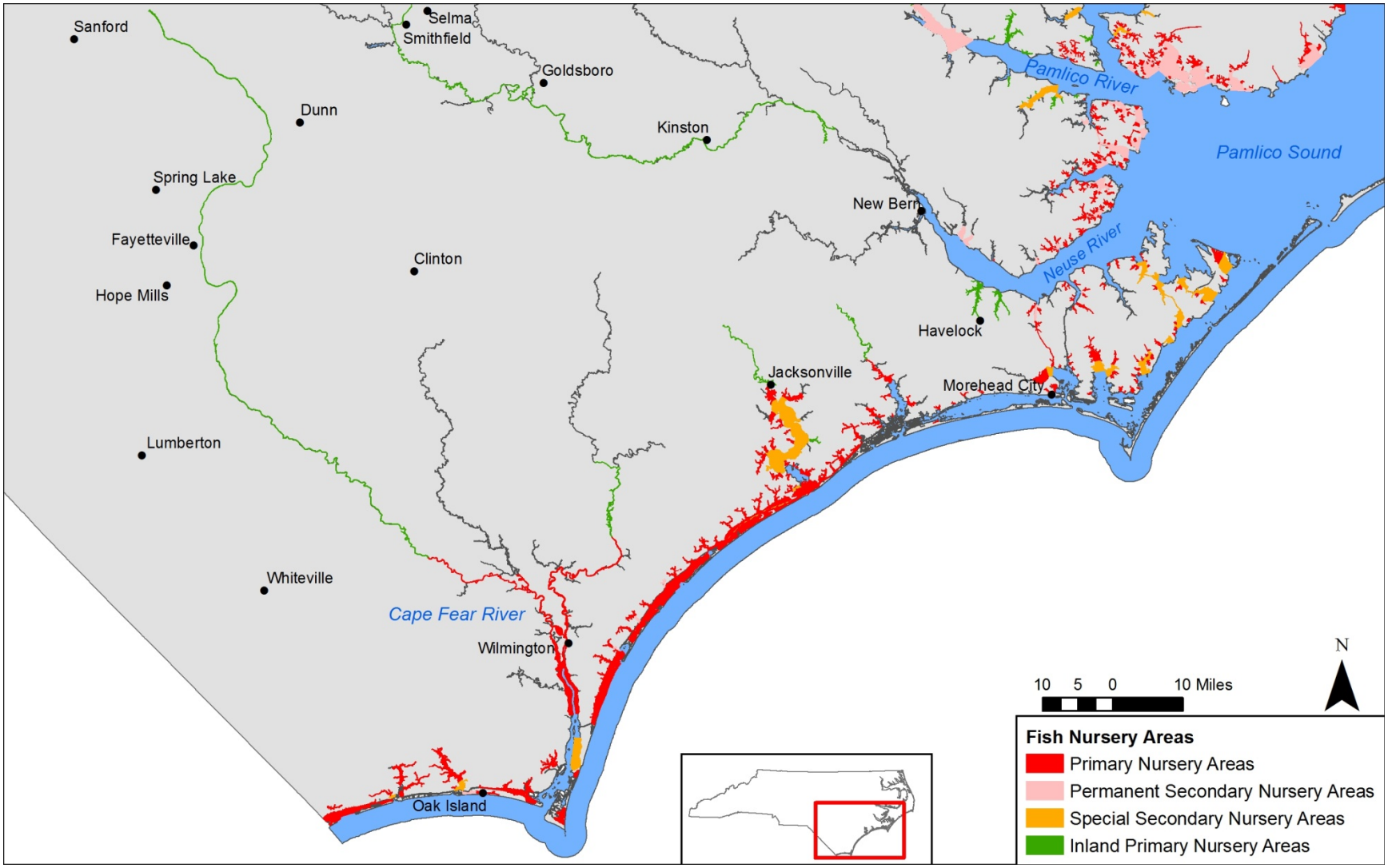


Figure 7. Nursery area designations in the Neuse River and Cape Fear River (including Northeast Cape Fear River, and Black River) areas.

Strategic Habitat Areas (SHAs) - CHPP Chapter 13.2

The identification and designation of Strategic Habitat Areas (SHAs) for marine and coastal fishery species is a critical component in the implementation of North Carolina's approved CHPP. Strategic Habitat Areas were defined in the CHPP as, "specific locations of individual fish habitat or systems of habitats that have been identified to provide exceptional habitat functions or that are particularly at risk due to imminent threats, vulnerability, or rarity" (Street *et al.* 2005). Criteria for identifying SHAs were developed by an advisory committee of the Marine Fisheries Commission established in summer 2005. The committee developed a scientifically based process for identifying candidate areas for designation using biological data and the consensus of a regional expert panel (regional advisory committee).

The identification of existing SHAs was conducted in a two step process: 1) using GIS-based habitat and alteration data in a computerized site-selection analysis, and 2) verifying and modifying information based on input from a scientific advisory committee. Staff and advisory committee specified representation levels for 42 habitat types, or natural resource targets. There were also 18 alteration factors that were represented geospatially (e.g., hydrologic alterations, water quality degradation). The site selection program MARXAN was used to select areas that met representation levels while also minimizing alteration. The scientific advisory committee then modified the computer results based on their unique knowledge and experience. The SHAs were corroborated with biological data, ecological designations, and specific knowledge of the area. The SHA nominations will be incorporated into conservation and restoration planning efforts.

SHA designations are based on regional analyses that identify optimally placed habitat areas of various ecological condition (exceptional or at risk). SHAs may include areas that have already been protected by other designations, as well as areas not currently recognized in any way. A network of designated SHAs providing habitat connections throughout North Carolina's coastal waters should ensure that the complex life history needs of all species are met. Once SHAs are designated in rule, resource managers may address gaps in existing management and take steps to prevent further alteration of the system as a whole. Thus, the necessary protections may go above and beyond current measures designed to protect habitat. Even before designation in rule, conservation agencies may incorporate candidate SHAs in their site selection process for acquisition, enhancement or restoration projects.

Four regions have been delineated for analysis and development of SHAs (Figure 8). As of May 2018, SHAs in all four regions have been identified and approved by the NCMFC. Regions 1, 2, 3, and 4 were presented and approved by the NCMFC in January 2009, November 2011, November 2014, and May 2018, respectively (Figure 9).

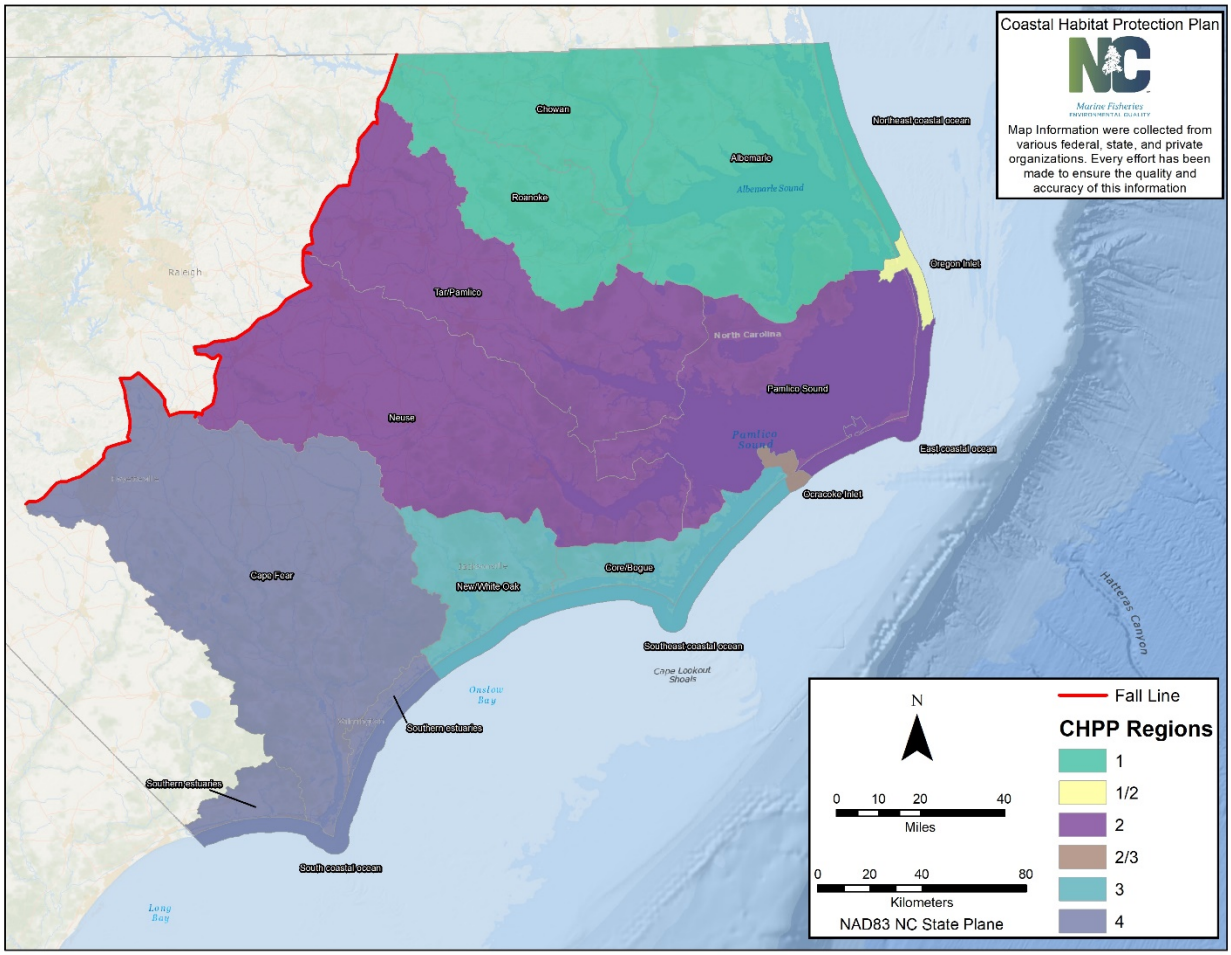


Figure 8. The CHPP region and subregion boundaries (based on USGS hydrologic units), along with the fall line separating Coastal Plains and Piedmont physiographic regions.

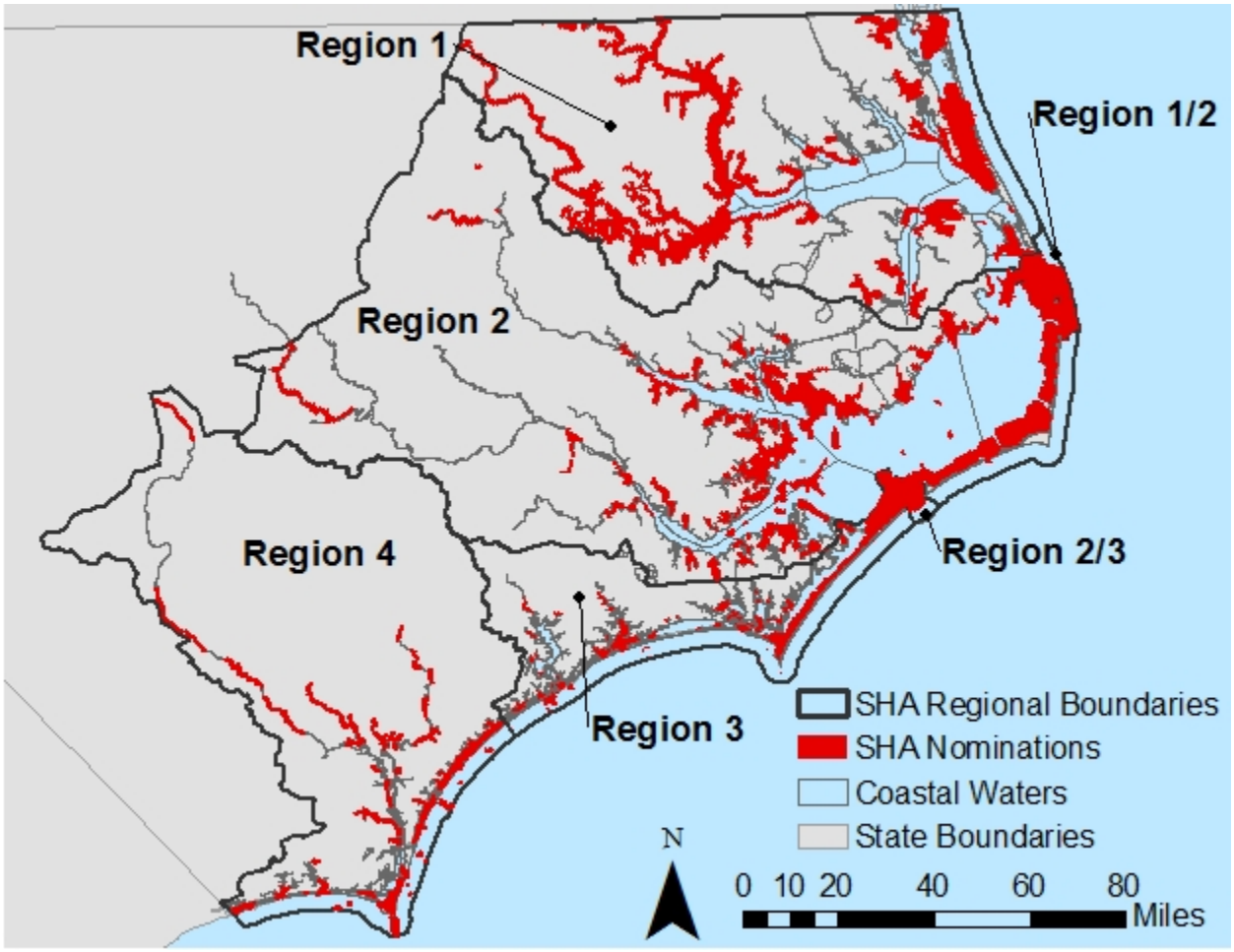


Figure 9. CHPP Regions 1, 2, 3, and 4 strategic habitat area nominations presented and approved by the Marine Fisheries Commission.

Section 2: Threats Assessment

Barriers to Migration Inventory and Assessment

The 2020 Atlantic States Marine Fisheries Commission's American Shad Stock Assessment and Peer Review Report provides an extensive review of available literature and discussion on the topic of fish passage (ASMFC 2020). Specifically, it highlights the issues with lack of evaluation and performance from decades-old approaches, facilities designs/operations that are not effective, and therefore cannot reasonably be expected to achieve management and restoration goals without significant changes. The Assessment Report also provides an important quantitative modeling approach examining shad habitat and passage barriers, and the need to address status quo fish passage performance. The impacts of these barriers and status quo passage are described and also modeled as effects on spawner population size under three scenarios, 1) no barriers, 2) first barrier with no passage, and 3) realistic fish passage performance measures applied to barriers (e.g., upstream passage efficiency of 50%).

The Assessment Report used standardized data and modelling approaches that quantified the impacts of barriers and fish passage as significant in all three management areas examined based on shad life history and habitat (New England, Mid-Atlantic, and South Atlantic). The

assessment determined that overall, dams completely or partly block nearly 40% of the total habitat once used by American Shad. The model results of the “no barriers” scenario yielded an estimated spawner production potential 1.7 times greater than that yielded by the scenario assuming no passage at the first barrier: 72.8 million versus 42.8 million fish. The results of the third model scenario, which applies “realistic” (i.e., current) fish passage efficiencies, resulted in a gain of less than 3 million fish. Conclusions include “losses in (spawner production) potential are significant in each state and region.” The Assessment Report provides a strong justification for the need and benefits of requiring improved fish passage performance measures. Additionally, meeting such improved passage performance standards is now an achievable goal given the current state of knowledge on fish behavior, swimming performance, and fish passage engineering expertise.

Dams - CHPP section 9.2.1; 9.2.2; 9.2.3; 9.2.5

The majority of dams in North Carolina occur in the upstream portions of estuaries, rivers, and streams. In the coastal plain, dams are most abundant in the upper reaches of the Cape Fear, Neuse, Tar-Pamlico, Roanoke, Chowan, and Yadkin-Pee Dee watersheds. These structures primarily impact anadromous fish and the catadromous American eel spawning migrations, (Figures 2-5). Eggs and larvae are less likely to survive if passage to their historical spawning areas is obstructed by dams or other alterations (Moser and Terra 1999).

In the coastal plains portion of CHPP Region 1, approximately 18% (2,369 miles) of National Hydrologic Dataset (NHD) streams (13,070 miles) appear blocked by an impoundment, based on strategic coastal habitat assessment results. The Chowan subregion of Region 1 had the largest percent of dam-obstructed streams at 38% (Table 1).

Table 1. Number of documented obstructions (e.g., dams, locks, culverts) in coastal plains portion of CHPP regions.

Data sources: Virginia Game and Inland Fisheries (1983 data), Collier and Odum (1989), Moser and Terra (1999), NCDOT (2003 data), NCDWR (2003 data), and USACE obstructions inventory (2009 data) 1.

CHPP Region	Subregion	Dam/impoundment	Beaver dam*	Lock*	Storm gate*	Vegetation*	Culvert (unspecified)	Pipe culvert	Box culvert**
1	Albemarle	2	0	1	4	2	33	39	3
	Chowan	95	1	0	0	0	25	46	5
	Roanoke	28	0	0	0	0	29	32	0
	TOTAL	125	1	1	4	2	87	117	8
2	Neuse	113	0	0	0	0	119	139	1
	Pamlico Sound	1	0	0	0	0	15	9	0
	Tar/Pamlico	73	0	0	0	0	95	68	0
	TOTAL	187	0	0	0	0	229	216	1
3	Core/Bogue	1	0	0	0	0	0	8	0
	New/White Oak	5	0	0	0	0	8	24	0
	TOTAL	6	0	0	0	0	8	32	0
4	Cape Fear	191	0	0	0	0	104	176	1
	Southern estuaries	3	0	0	0	0	1	6	0
	TOTAL	194	0	0	0	0	105	182	1
ALL	TOTAL	512	1	1	4	2	429	547	10

[1] Note: Structures duplicated in different datasets were consolidated into one dataset.

* Collier and Odum (1989) only

** Moser and Terra (1999) only

Additional information on aquatic barriers in North Carolina can be found using the Southeast Aquatic Barrier Prioritization Tool (https://connectivity.sarpdata.com/). The Southeast Aquatic Resources Partnership has compiled an inventory and living database of dams, culverts, and other road crossings and other road crossings for 14 states in the southeast. While the information on barriers is not complete or comprehensive across the region, a large portion of North Carolina's aquatic barriers have been inventoried. The inventory directly supports prioritization of barriers by including metrics that describe network connectivity, landscape condition, and presence of threatened and endangered aquatic organisms.

Other Physical Structures - CHPP section 9.2.4

Based on analysis of NCDEQ and NC Department of Transportation (NCDOT) records, it has been estimated that the state loses, on average, about 500 acres of wetlands per year, mostly from road construction (see "Culverts and Road Fill" section of the Hydrological Alterations chapter for more information). Road construction over rivers, streams, or wetlands often involves blockage of a portion of the original stream channel and floodplain. Bridges may cross over the water or culverts may be constructed under the road, depending on the size of stream and associated wetlands. In the past, bridges were constructed by filling the adjoining wetlands and creating a narrow channel for water passage.

Altered Water Quality and Quantity - CHPP section 10.2

Besides degrading water quality, modifications to normal flow conditions (e.g., stream blockages, water withdrawals, droughts, or discharges) can negatively impact anadromous fish migrations, including American shad.

Water Withdrawals Inventory and Assessment - CHPP Section 9.3.1

Water is withdrawn from surface and ground waters for multiple purposes. Surface water is withdrawn for industrial uses (such as cooling water for nuclear and fossil fuel power plants), municipal water supply, crop irrigation, and other uses. Thermoelectric power generation accounts for the greatest amount of surface water withdrawals followed by public water supply, irrigation, industrial, and aquaculture withdrawals in the CHPP regions.

Specific information regarding the type and quantity of water withdrawals for each basin is catalogued by the NC Division of Water Resources (NCDWR 2001).

Toxic and Thermal Discharges Inventory and Assessment - CHPP Section 10.2.2; 10.2.3; 10.2.4; 10.2.5

Both direct (point source) and indirect (non-point source) discharges occur in the river systems that support American shad, and can contain a variety of stressors that are generally dependent on adjacent land use. Common stressors contained in both point and non-point discharges are nutrients and toxins (e.g., chlorinated hydrocarbons).

Several of these major rivers flow into estuarine environments that are characterized by slowly moving, poorly flushed waters with high level of nutrients, which offer ideal conditions for various algae, fungi, and bacteria to thrive. Toxins can exist in the water column as well as adhere to bottom sediments. General information regarding discharges of nutrients and toxins is presented in the CHPP with specifics for each river basin. Additional information regarding North Carolina water quality data assessments and impaired waters list can be found on the NC Division of Water Resources (NCDWR) website (https://deq.nc.gov/about/divisions/water-resources/planning/modeling-assessment/water-quality-data-assessment/integrated-report-files).

Channelization and Dredging Inventory and Assessment - CHPP Section 9.3.2; 8.2.3

Water Column, wetlands, SAV, and soft bottom, all of which are critical to American shad stocks, are directly threatened by dredging and channelization. Not only will dredging directly affect American shad stocks, the sedimentation and turbidity associated with it will have adverse impacts on American shad.

Much of NC's estuarine waters are shallow and these shallow waters are where most structured habitats like wetlands, SAV, and shell bottom occur. Dredging can consist of deepening existing shallow water habitat or creating new waters from upland in the form of canals, boat basins, marinas, or ditches. This is generally done for the purpose of navigation or drainage for flood or mosquito control. The latter is no longer permitted.

Land Use Inventory and Assessment - CHPP Section 1.7.1; 10.1

Land use and land cover vary from North Carolina's oceanfront shoreline to the freshwater upstream limit of American shad in coastal river systems. Statewide the dominant land cover is forest, followed by agriculture, and developed land. In the flat and relatively low elevation of the coastal plain, marsh and forested wetlands are very abundant. Forest land can be upland or

wetland and can be managed (silvaculture) or natural (undisturbed). Forestry and agriculture are the biggest industries in terms of land cover in the coastal plain.

Land cover and water quality within a watershed are closely linked. The impact of land uses on fish habitat and water quality depends on the location of the land uses in the watershed as well as local weather conditions (rainfall, winds etc.). For additional information on land use change data please refer to the NOAA Coastal Change Analysis Program (C-CAP) 2016 Regional Land Cover and Change Data Set (https://coast.noaa.gov/digitalcoast/data/).

Atmospheric Deposition Inventory and Assessment - CHPP Section 10.3.3

The effect of atmospheric deposition on water quality is difficult to trace. Sources of atmospheric pollutants include vehicle exhaust, industrial emissions, and waste from animal operations (Walker et al. 2000; USGS 2003). Atmospheric deposition was the source implicated in 7.9% of impaired coastal draining streams in North Carolina (NCDWQ 2006). The greatest number of streams impaired from atmospheric deposition occurred in the Roanoke River Basin. A significant portion of nutrient pollution has also been attributed to atmospheric deposition.

Climate Change Inventory and Assessment

On October 29, 2018, North Carolina Governor Roy Cooper issued Executive Order No. 80 (EO80), which outlines North Carolina's commitment to addressing climate change and transition to a clean energy economy. The North Carolina Climate Science Report (NCCSR) supports Governor Cooper's EO80 by providing an independent peer-reviewed scientific contribution to the EO80. The NCCSR is a scientific assessment of historical climate trends and potential future climate change in North Carolina under increased greenhouse gas concentrations (https://ncics.org/programs/nccsr/). The report was prepared independently by North Carolina-based climate experts and an advisory panel was formed to provide oversight and review of the report. The report underwent several rounds of review and revision, including an anonymous peer review organized by NOAA's National Centers for Environmental Information (NCEI). The NCCSR was released in March 2020 and revised in September 2020 to enhance accessibility of the report.

The report found that large changes in North Carolina's climate are very likely to occur by the end of this century (Kunkel *et al* 2020). North Carolina annual average temperature has increased by about 1.0°F since 1895, less than global average (Kunkel *et al* 2020). However, 2009-2018 represent the warmest 10-year period on record in North Carolina, averaging about 0.6°F warmer than the warmest decade in the 20th century (1930-1939; Kunkel *et al* 2020). Sea level along the northeastern coast of North Carolina has risen about twice as fast as the southeastern coast, averaging 1.8 inches per decade since 1978 at Duck, NC, and 0.9 inches per decade since 1935 at Wilmington, NC (Kunkel *et al* 2020). The report predicted that by the end of the century all of the state's coast will experience disruptive coastal flooding. While the report found no long-term trend in annual total precipitation, there is an upward trend in the number of heavy rainfall events (3 inches or more in a day), from 2015-2018 (Kunkel *et al* 2020).

Competition and Predation by Invasive and Managed Species Inventory and Assessment - CHPP 11.1

There is widespread documentation that some non-native species can out-compete native species, altering the established ecosystem, habitat, and eventually water quality (Mallin *et al.* 2001, Burkholder *et al.* 2007).

The most troublesome submerged aquatic plant species in low-salinity estuarine waters are Eurasian watermilfoil (*Myriophyllum spicatum*) and hydrilla (*Hydrilla verticillata*). It is possible for Eurasian watermilfoil and hydrilla to become thick dense beds that will out compete native SAV species. The presence of these two species may remove critical habitat by "choking" out native species or fish kills may arise due to low dissolved oxygen levels. Hydrilla has been documented in many of the North Carolina coastal rivers and the Albemarle Sound.

The NCDEQ is charged with the regulation of noxious weeds in the Aquatic Weed Control Act of 1991 (Article 15 113A-220). By virtue of the regulations created following the act (T15A NCAC 02G .0600), NCDWR implements the Aquatic Weed Control Program (AWCP), which focuses primarily on non-native invasive species in freshwater lakes, ponds, and rivers. Weed control activities in coastal waters are primarily focused on Eurasian watermilfoil. Control activities target areas where native species are not the dominant species based on site assessments (R. Emens NCDWR, personal communication 2009).

Both the blue catfish (*Ictalurus furcatus*) and flathead catfish (*Pylodictis olivaris*) are nonnative catfish species in coastal North Carolina that are known to prey on native fishes including river herring and American shad. In North Carolina flathead catfish do not target native species, but they are opportunistic feeders eating whatever becomes available (Pine *et al.* 2005) but both species have been documented to consume river herring (Schloesser et al. 2011). At the current time, the blue catfish population is expanding in the Albemarle Sound and its tributaries but the extent of its effect on river herring and American shad is unknown. Flathead catfish have yet to be documented in the Albemarle Sound region, but they are present in all other river basins, including some coastal waters, in the state (NCDMF and NCWRC unpublished data). While the impact of blue catfish and flathead catfish predation on American shad in North Carolina is unknown, we assume American shad are just a vulnerable as river herring due to the opportunistic feeding behavior of these invasive species. Neither the NCDMF nor the NCWRC has regulations to restrict harvest of invasive catfishes in North Carolina coastal rivers and sounds in attempts to control their populations.

Section 3: Habitat Restoration Program

Barrier Removal and Fish Passage Program

Chowan Watershed

In the Chowan watershed, there is one hydropower dam on the Meherrin River, and one on the Nottaway River (Baskerville Mill Dam), both in Virginia. In addition to dams found on mainstem rivers, numerous smaller mill dams are found on creeks throughout eastern North Carolina. For example, Collier and Odom (1989) reported three such dams within the Chowan River basin on Bennetts, Indian, and Rockyhock creeks (Figure 2). The dams on mainstem and tributary portions of the Chowan drainage basin form the upstream boundaries of some documented anadromous fish spawning habitat in North Carolina and Virginia. Although there is a fish passage structure, the upstream boundaries include the Emporia Dam on the Meherrin River in Virginia (Collier and Odom 1989). The structure at the dam does not effectively pass fish upstream. Removing or bypassing these dams would open access to many miles of potential spawning habitat for anadromous species including American shad. Recent fish passage improvements in the Chowan watershed include fish ladders at Merchant's Millpond on Bennett's Creek and Dillard's Millpond on Indian Creek (Mike Wicker USFWS, personal communication, 2005), but these improvements are only beneficial for river herring.

Roanoke River

Currently, numerous large and small dams are present in the Roanoke River Basin. Roanoke Rapids Dam at river kilometer (rkm) 220 (river mile 137) is the lowermost dam on the mainstem of the river. Roanoke Rapids Dam impounds the river to Gaston Dam at rkm 233 (river mile 145). Gaston Dam impounds the river to rkm 274 (river mile 170), below Kerr Dam at rkm 288 (river mile 179). Kerr Dam impounds the river up the Dan River to rkm 332 (river mile 206), and up the Staunton River to rkm 341 (river mile 212; Laney et al. 2001). State and federal fisheries management agencies in North Carolina and Virginia finalized negotiations with Dominion/NC Power for relicensing of the Gaston and Roanoke Rapids lakes hydroelectric dams through the Federal Energy Regulatory Commission (FERC) in 2005. Among the mitigative measures required by relicensing was a long-term, well-funded, and coordinated program to restore American shad in the Roanoke River 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, and an assessment of American shad population size, using hydroacoustic techniques, as it pertains to providing upstream passage facilities and fulfilling the prescription for fish ways provided by NMFS. The Diadromous Fishes Restoration Technical Advisory Committee (DFRTAC), comprised of Dominion staff and state and federal resource managers, advises implementation of Dominion's settlement agreement. Due to numerous studies showing ineffective downstream passage of stocked fish and continued low spawning population estimates, the DFRTAC has delayed the design and construction of American shad passage facilities at Roanoke Rapids Dam as prescribed in the settlement agreement. Nevertheless, the fish ways prescription and the settlement agreement established a process for providing American shad access to spawning habitat in the upper Roanoke River that can be implemented when conditions are appropriate.

Tar/Pamlico River

The Rocky Mount Mills Dam is the lowermost dam on the Tar River that obstructs migration of striped bass, American shad, Atlantic sturgeon, hickory shad, and blueback herring (Collier and Odom 1989). The dam was constructed on the Tar River near the City of Rocky Mount in approximately 1816. The dam provided power for gristmill, sawmill, and textile industries. In 1949, hydro-electric turbines were installed, and the dam produced electricity in addition to the textile manufacturing (GEO 2019). The textile mill closed in 1996, but the hydropower operation continued through approximately 2013 (EPA 2019). The current owners of the dam and associated hydropower facility plan to refurbish the turbines and resume power generation in the future. Operation for the benefit of fish spawning and providing fish passage will not be required because the dam is not regulated by FERC; however, the owners have been receptive to fish passage ideas and seem willing to cooperate with beneficial flows (Wilson Laney, USFWS ret., personal communication). Rocky Mount Mills Dam will continue to represent a barrier to American shad migration on the Tar River until its removal or development of fish passage.

Neuse River

The first blockage in the Neuse River is Falls of Neuse Dam at rkm 314 (river mile 195). A substantial amount of mainstem habitat was restored in 1998 with the removal of the Quaker Neck Dam near Goldsboro (Bowman and Hightower 2001). In 2017, the Milburnie Dam rkm 295 (river mile 183) was removed providing access to more than ten kilometers (six miles) of potential spawning habitat. Removal of Milburnie Dam also allows the USACE some latitude to provide a stable flow regime for the Neuse.

Little River, a Neuse River tributary, has had three low-head dams removed since 1998. Cherry Hospital Dam, Rain Mills Dam, and Lowell Mill Dam have been removed and have reconnected 82 river kilometers (51 river miles) of Little River to the Neuse River and 237 river kilometers (147 river miles) including Little River tributaries. Raabe and Hightower (2014) estimated that 24-31% of American shad and 45-49% of gizzard shad migrated past the former Lowell Mill dam site in 2009 and 2010. A partially removed dam, which provides for a back-up water intake structure for the city of Goldsboro, still exists just upstream of the former Cherry Hospital Dam. This remaining structure appears to impede the upstream migration of American shad and gizzard shad, blocking some individuals and delaying others (Raabe and Hightower 2014).

Cape Fear River

In the Cape Fear River, the lowermost obstructions to migration are the three locks and dams located within the Coastal Plain operated by the USACE. Above the final lock, Buckhorn Dam at rkm 316 (river mile 196) prevents further migrations to potential upstream spawning habitat except during extreme flood events. The Cape Fear River may provide the best opportunity for remediation of obstructions. In November 2012, the USACE completed construction on a rock ramp fish passage for the lower most lock and dam. State and federal natural resource agencies, along with university and non-governmental organizations, have partnered to develop a Cape Fear Basin Action Plan for Migratory Fish (http://www.habitat.noaa.gov/protection/capefear/pdf/CapeFearActionPlan.pdf).

Telemetry studies conducted to evaluate American shad usage of the rock arch fishway indicate American shad passage efficiency at the Lock and Dam 1 (LD-1) fishway ranged 53–65% and was consistent with prior estimates from locking procedures (Raabe et al. 2019). 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, NCWRC 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 2016, NCWRC staff documented higher egg densities below LD-3 compared to other locks and dams (Morgeson and Fisk 2018). 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.

Following the construction of the fish passageway at LD-1, natural resource agencies have advocated for removal or construction of fish passage structures at LD-2 and LD-3. Restoration efforts through removal or modification of dam structures that impede migration of anadromous fish should remain a high priority to continue in North Carolina, focusing on the lowermost structures in rivers or streams, and advancing upstream. In particular, the Cape Fear system, LD-2 should be a high priority, since striped bass, shortnose sturgeon, and Atlantic sturgeon have not recovered. In late 2015, the North Carolina General Assembly approved $250,000 to be used towards the engineering and design of a fish passage at Lock and Dam 2. The funds require a 50/50 match of non-federal monies. Fundraising for the matching funds is currently

under way by the Cape Fear River Partnership. However, the USACE authorized a disposition study in 2019, and the fate of the dams, including continued ownership by the USACE and any future improvements, is in question pending the study.

Hatchery Product Supplementation Program

American shad fry reared at the USFWS Edenton National Fish Hatchery (ENFH) and at the NCWRC Watha State Fish Hatchery have been stocked annually into the Roanoke River since 1998. This restoration project was initiated by NCWRC, and although it was originally funded by the North Carolina Department of Transportation as mitigation for aquatic habitat damages resulting from highway bridge construction on the Roanoke River, continued American shad stocking efforts have primarily been funded by Sport Fish Restoration Funds and Dominion Energy through their FERC settlement agreement requirements. Annual production and stocking information can be found in North Carolina's annual Shad and River Herring Compliance reports. In 2019, however, NCWRC and other program partners decided to temporarily halt the Roanoke River restoration program for at least three years due to growing concerns about high hatchery contribution and decreasing genetic diversity without population growth. A similar, but smaller scale American Shad restoration program began in the Neuse River in 2012 to supplement the wild population by stocking fry produced from one spawning tank of approximately 100 broodfish each year. The Neuse River restoration program was also stopped in 2019.

Annual contribution of hatchery-origin American shad to the Roanoke River and Neuse River populations is evaluated for multiple cohorts of returning adults during the spring spawning run. Fin clips from adult American shad are collected during spawning stock surveys, and broodfish are also evaluated for potential hatchery contribution of stockings from previous years. Parentage-based tagging analysis using genetic, microsatellite markers has been used to examine adult and juvenile fin clips for hatchery origin since 2010, and OTC was used in prior years. Although stockings were halted in 2019, evaluation of previously stocked cohorts will continue.

Water Quality Improvement Program-CHPP 14

One of the four major goals of the CHPP is "Enhance and protect water quality" and significant cooperation among agencies has occurred in pursuit of this goal. The most recent CHPP Implementation Plan 2018-2020, as well as recent annual reports can be found on the CHPP website (http://portal.ncdenr.org/web/mf/habitat/chpp/07-2020-chpp). The implementation plans outline specific items regarding water quality while the annual reports provide details on progress on items contained in the Implementation Plan. A separate improvement plan for water quality is not needed because the implementation plans outline specific actions to address water quality.

In 2010, the North Carolina General Assembly directed the NCDEQ to develop basinwide hydrologic models for all 17 river basins in North Carolina (https://deq.nc.gov/about/divisions/water-resources/water-planning/modeling-assessment/basinwide-hydrologic-modeling). For long term planning, NCDEQ uses hydrologic models for evaluating potential impacts of proposed projects with new or increased water withdrawals within the basin as well as interbasin transfers. Local stakeholders as well as DEQ use these models to plan for increased water use due to growth and to evaluate the effects of operational and regulatory constraints during a drought condition. To date basinwide models have been completed for the Cape Fear-Neuse river (combined), Roanoke River, and Tar River.

The NCDWR is actively working to develop appropriate nutrient criteria for the waters of the state. The NCDWR's goal is to develop scientifically defensible criteria based primarily on the linkage between nutrient concentrations and protection of designated uses. The criteria for each water body will be coordinated with other water bodies to ensure consistency across the state and protect downstream uses. The nutrient criteria development plan for 2019 can be found on the NCDWR website (https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/nutrient-criteria-development-plan). Nutrient criteria development efforts will be directed to the three specific water body types: 1) reservoirs/lakes, 2) rivers/streams and 3) estuaries. Currently, the plan is using the Albemarle Sound as the pilot water body for estuaries. The timeline for development and adoption of nutrient criteria in the 2019 plan is 2025. Adoption of nutrient criteria statewide is anticipated by 2029.

Habitat Improvement Program-CHPP 14

Similar to the Water Quality Improvement Program, the CHPP Implementation Plan fills the role of a Habitat Improvement Program. Two of the four major CHPP goals are directly related to habitat protection and improvement: "Identify, designate and protect strategic habitat areas" and "Enhance habitat and protect it from physical impacts." The CHPP Implementation Plan 2018-2020 details the component of and progress towards several efforts aimed at improving fisheries habitat in North Carolina (http://portal.ncdenr.org/web/mf/habitat/chpp/07-2020-chpp). A separate improvement plan for habitat improvement is not needed because the implementation plans outline specific actions to address habitat concerns.

In 2010, American Rivers initiated a dam removal program in North Carolina. This organization has been working with state and federal agencies to prioritize which dams should and can be removed. While creating this list, American Rivers has been actively trying to obtain funding to remove dams. In partnership with the American Rivers organization and other state and federal councils and fish and wildlife agencies, the Southeast Aquatic Resources Partnership has been working with partners cross 14 southeast states to inventory aquatic barriers since 2013. Recently, the Southeast Aquatic Resources Partnership launched the Aquatic Barrier Prioritization Tool (https://connectivity.sarpdata.com/). This interactive tool contains a living database and GIS assessment of aquatic barriers in the southeast. This information allows partners to prioritize dams and road-stream crossings for potential removal or remediation based on ecological metrics. Researchers at NCDEQ, NCWRC and East Carolina University (R. Rulifson and J.P. Walsh) have contributed to the assessment in estimating the acreage of habitat gained by the removal of the first and second obstructions on North Carolina coastal rivers.

Additionally, staffs from NCDMF and NCWRC, as well as other federal and state agencies participate in several cooperative efforts to improve fish passage, including the ASMFC Fish Passage workgroup.

Project Permit/Licensing Review and Minimization Programs-CHPP 14

During the 2008-2009 fiscal year the NCDMF received approval for two grant funded position dedicated to NC Division of Coastal Management (NCDCM) permit review. NCDMF through NCDCM participates in an extensive permit review process on behalf of 15 federal and state agencies. NCDMF is specifically authorized by state statute to review and comment on permits that may impact public trust resources and has established a set of internal guidelines for staff in order to maintain a consistent review process. Dedicated staff conduct reviews on permits related to coastal development, while programmatic fisheries staff take the lead in reviewing federal permits for particular species.

In 2009, the NCMFC approved a compensatory mitigation policy that was incorporated into the "Policies for Protection and Restoration of Marine and Estuarine Resources and Environmental Permit Review and Commenting." Based on evolving understanding of the needs of compensatory mitigation to protect and enhance the quality of coastal waters and watersheds, the focus and goals of compensatory mitigation should allow an array of options to be applied. The NCMFC has delegated its permit commenting authority to its Habitat and Water Quality Standing Advisory Committee (Committee) for the sake of efficiency and effectiveness.

State and federal laws charge the NCWRC with protecting, managing and conserving aquatic, wetland and upland habitats for the benefit of fish and wildlife populations. The Habitat Conservation Program implements this mandate based upon the NCWRC's Policies and Guidelines for Conservation of Wetlands and Aquatic Habitats. The NCWRC Habitat and Conservation Program reviews proposed projects statewide and evaluates the potential environmental threats associated with each project. The program recommends project design modification to minimize adverse environmental impacts and recommends mitigation to compensate for unavoidable impacts. A large portion of the coastal region permit review is associated with shoreline stabilization, piers construction, marina development and small channel dredging.

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South Carolina Department of Natural Resources
Georgia Department of Natural Resources

American Shad Habitat Plan for the Savannah River

Submitted to the Atlantic States Marine Fisheries Commission as a requirement of Amendment 3 to the Interstate Management Plan for Shad and River Herring

Approved: February 6, 2014

Updated: December 2020

Savannah River American Shad Habitat Plan
submitted by
Georgia and South Carolina

Habitat Assessment

Tributaries of the Savannah River begin in the Appalachian Mountains in Georgia, North Carolina, and South Carolina. The Savannah River begins at the confluence of the Tugaloo River and the Chattooga River and flows 506 kilometers (km) across the piedmont and coastal plain before emptying into the Atlantic Ocean. The river serves as the border between Georgia and South Carolina throughout its entire length and has a watershed of approximately 27,255 km^2. Tidal influence typically extends to km 56 and the fresh/saltwater interface occurs approximately 22 km upstream from the mouth of the river.

There are no physical obstructions to the amount of historical estuarine habitat available to migrating adults or young-of-the-year fish in the Savannah River. However, major river channel modifications for shipping and commerce have occurred since colonial times. The impacts from these actions have altered salinity, decreased dissolved oxygen at depth, increased flushing rates in the lower estuary, and reduced freshwater tidal wetlands (Reinert 2004). For example, the installation and operation of a tide gate on the Back River channel and harbor deepening projects altered salinity and dissolved oxygen in a section of the lower river. Due to these impacts, the tide gate was removed in 1991, thus restoring a more natural flow regime. A major project to deepen the harbor in Savannah, GA to accommodate larger ships in the future was partially completed in 2018-2019.

The first barrier to upstream migration on the Savannah River is the New Savannah Bluff Lock and Dam (NSBLD) located at km 301 near Augusta, Georgia. The lock at NSBLD was designed for navigation and initially provided very limited fish passage. In the late 1980s, identification and documentation of more efficient passage methodologies were completed at the NSBLD and were implemented annually until 2014, when the lock was permanently closed. Consequently, the NSBLD is now the first true barrier with no dedicated fish passage. The next true barrier with no dedicated fish passage is the Augusta Diversion Dam located at km 333.

Historic Habitat

American shad had access to the entire Savannah River and its tributaries throughout the 27,255 km^2 watershed (South Carolina's portion of the watershed occupies 11,864 km^2). According to Welch (2000), the only record that could be found describing the inland distribution of American shad was from Stevenson's 1899 report where he firmly places the historical inland migration of American shad at "Tallulah Falls, 617 km by the river course from the sea".

Current Useable Habitat

Spawning - American shad begin spawning in tidal freshwater near km 64 (McCord 2003) and have about 237 km of suitable riverine channel habitat for spawning in the Savannah River below the New Savannah Bluff Lock and Dam. Between the late 1980's and 2014, efficient passage methodologies were implemented annually allowing American shad access to an additional 32 km of the Savannah River to the base of the Augusta Diversion Dam (km 333), the first barrier with no dedicated fish passage. This has changed with the permanent closure of the lock at NSBLD in 2014.

Rearing - Suitable rearing habitats are similar to the listed waterways for suitable spawning habitat with the addition of 10,031 ha of estuary in the Savannah River basin (DHEC).

Threats Assessment

a. Barriers to migration inventory and assessment

There are currently 6 dams on the main stem of the Savannah River. The US Fish and Wildlife Service developed a diadromous fish restoration plan (Hill 2005) for the middle Savannah River that includes establishing fish passage at the next two main stem Savannah River barriers and barriers within the Stevens Creek tributary system. Additionally, plans to improve fish passage at NSBLD have been developed as a part of the mitigation plan for deepening the Savannah shipping harbor and would enhance passage to approximately 33 km of the Savannah River below the Augusta diversion dam. If fully implemented, approximately 77 km miles of main-stem river, and 72 km of tributary reaches would be made available through provision of fish passage at the Augusta Diversion Dam and Stevens Creek Dam. This includes approximately 2,917 acres of potential new habitat. The lowermost dam in the Savannah River is the New Savannah Bluff Lock and Dam (NSBL&D at km 301).

Name	Pupose	Owner	Height (ft.)	Width (ft.)	Length (ft.)	Impoundment size	Water storage capacity	Location	River Kilometer	Fish Passage	Method
NSBL&D	Hydro	USACE	~25	~45	4109	2,866 acre	30,893 acre/ft.	34.982947°N/79.877540°W	301	Yes	Lock

Action 1: Improve fish passage at the New Savannah Bluff Lock and Dam

Regulatory Agencies/Contacts: The United States Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), United States Army Corps of Engineers (USACE), Georgia Department of Natural Resources (GA DNR), South Carolina Department of Natural Resources (SC DNR), City of Augusta, and federal and state legislators.

Goal/Target: Construct a fishway that will effectively pass diadromous fish species.

Progress: Mitigation plans for expansion of the Savannah River harbor included construction of a new fish passage system at NSBLD. USACE completed design work for the new fish passage, however changes to the NMFS biological opinion dredging has already been initiated in the harbor. These plans call for the construction of a series of terraced rock ramps on the South Carolina side of the river. During periods of low flow, the gates could be closed to divert the total flow of the river to the off-channel rock ramp. Legal action is currently underway, thus all NSBLD changes are being suspended until such legal measures are decided.

Cost: $30,000,000

Timeline: Dependent upon funding

Action 2: Fish passage at the Augusta Diversion Dam and Stevens Creek Dam

Regulatory Agencies/Contacts: The USFWS, NMFS, USACE, GA DNR, SC DNR, City of Augusta, and federal and state legislators.

Goal/Target: The National Marine Fisheries Service (NMFS) goal is to concurrently initiate construction and operation of fishways at both the Augusta Diversion Dam and the Stevens Creek Dam to ensure fish passage above both projects, allowing access to the main-stem Savannah River, and major tributaries.

Progress: The relicensing of the Augusta Diversion Canal and Stevens Creek projects provided an opportunity to consider diadromous fish needs and resulted in a fishway prescription from the Secretaries of Interior and Commerce. Upstream passage at Stevens Creek Dam is required following the construction of a fishway at the Augusta Diversion Dam.

Augusta Diversion Dam

In August 2004 the USFWS and NMFS submitted a preliminary fishway prescription for the Augusta Canal Hydropower Project that included a vertical slot fishway on the Georgia side of the river. Based on comments received from the City of Augusta, and additional evaluation and review by the USFWS and NMFS, the fishway prescription was modified to include a vertical slot fishway on the South Carolina side of the Savannah River. Negotiations between the USFWS and NMFS and project operator are still ongoing and construction of the fishway has not been initiated.

Stevens Creek Dam

The Section 18 prescription in the current license for the Stevens Creek project includes a requirement to refurbish the navigation lock, which will be operated using attraction flows or other fish attraction mechanisms to provide a minimum of 30 lockages during the shad migration season. The prescription requires construction and operation of the USFWS and NMFS approved final fishway design following construction of fish passage facilities at the Augusta Diversion Dam. The USFWS and NMFS also reserve the authority to further evaluate alternative fishway designs.

Cost: Unknown

Timeline: Unknown

Action 3: Fish passage at the Stevens Creek Mill Dams

Regulatory Agencies/Contacts: The USFWS, NMFS, USACE, SC DNR, dam owners, and federal and state legislators.

Goal/Target: Establish fish passage on the Stevens Creek tributary to the Savannah River following the establishment of fishways at the Augusta Diversion Dam and Stevens Creek Dam.

Progress: Two historical mill dams have been identified on the mainstem of Stevens Creek. Price's Mill Dam is located just downstream of SSR 138, and Parks Mill Dam is located just upstream of Hwy 23 both in Edgefield County, South Carolina. Although both dams are less than 15 feet in height and operate as run-of-river, each is a barrier to movements of anadromous and riverine fish. Future anadromous fish restoration efforts may include evaluating potential alternatives at the dams to provide fish passage to upstream habitats including access to Stevens Creek, Cuffytown Creek and Hard Labor Creek. Possible passage alternatives include full removal, notching, or construction of fish passage facilities.

Cost: Unknown

Timeline: Unknown

b. The following is a list of point source and nonpoint source activities that occur in the Savannah River

Nonpoint Source Management Program				
Landfill Facilities	***Status***	***Permit #***	***Section Number***	***Section Name***
SRS 632-G C&D LANDFILL	Solid Waste	065800-1901	03060106-08	(Savannah River)
USDOE WESTINGHOUSE SRS	Solid Waste	025800-1901	03060106-08	(Savannah River)
Active NPDES Facilities	***Facility Type***	***Permit Number***	***Section Number***	***Section Name***
BJW&SA/HARDEEVILLE CHURCH ROAD	MAJOR DOMESTIC	SC0034584	03060109-03	(Savannah River)
RINKER MATERIALS/DEERFIELD PIT	MINOR INDUSTRIAL	SCG730624	03060109-03	(Savannah River)
REED-HTI/SAVANNAH LAKE MINE	MINOR INDUSTRIAL	SCG731042	03060109-03	(Savannah River)
TOWN OF ALLENDALE WWTP	MAJOR DOMESTIC	SC0039918	03060106-09	(Savannah River)
CLAIRIANT CORP./MARTIN PLT	MAJOR INDUSTRIAL	SC0042803	03060106-09	(Savannah River)
USDOE WESTINGHOUSE SRS	MAJOR INDUSTRIAL	SC0000175	03060106-08	(Savannah River)
USDOE WESTINGHOUSE SRS	MAJOR INDUSTRIAL	SC0000175	03060106-08	(Savannah River)
USDOE WESTINGHOUSE SRS	MAJOR INDUSTRIAL	SC0000175	03060106-08	(Savannah River)
USDOE WESTINGHOUSE SRS	MAJOR INDUSTRIAL	SC0000175	03060106-08	(Savannah River)
USDOE WESTINGHOUSE SRS	MAJOR INDUSTRIAL	SC0000175	03060106-08	(Savannah River)
ECW&SA/WTP	MINOR INDUSTRIAL	SCG645036	03060106-06	(Savannah River)
KIMBERLY-CLARK CORP./BEECH ISLAND	MAJOR INDUSTRIAL	SC0000582	03060106-06	(Savannah River)
SCE&G/URQUHART STEAM STATION	MAJOR INDUSTRIAL	SC0000574	03060106-06	(Savannah River)
AIKEN PSA/HORSE CREEK WWTP	MAJOR INDUSTRIAL	SC0024457	03060106-06	(Savannah River)
US ARMY CORPS./LAKE THURMOND	MINOR INDUSTRIAL	SC0047317	03060106-01	(Savannah River/Stevens Creek Reservoir)

All point source and nonpoint sources that occur in the Savannah River are closely monitored by the South Carolina's Department of Health Environmental Control (DHEC) and Georgia Environmental Protection Division (GAEPD). All discharges are held to water quality standards for the states. Therefore, it is highly unlikely these programs impact American shad migration and utilization of historic habitat. In addition, all programs are currently undergoing 316a to assess the likelihood of impingement or entrainment.

c. Toxic and thermal discharge inventory and assessment-none

d. Channelization and dredging inventory and assessment

The following is a list of historic dredging programs that occurred in the Savannah River System:

Start_Date	River	DA_Number	Action_Typ	Project_Na	County	Latitude	Longitude
11/4/1993	Savannah	SAC-1993-10125	SP	RAW WATER CANAL MODIFICATION	Jasper	32.342970	-81.130920

The Savannah River Harbor Expansion Plan (SHEP) includes dredging the Inner Harbor from a depth of 42-foot to a depth of 48-foot and could exacerbate low seasonal dissolved oxygen levels in this portion of the river.

Dissolved Oxygen-Low dissolved oxygen levels have been documented in a portion of the lower Savannah River, particularly during low flow periods in summer months.

Action 1: Mitigate potential impacts on dissolved oxygen levels due to SHEP.

Regulatory Agencies/Contacts: The USFWS, NMFS, USACE, GA DNR, SC DNR, Georgia Ports Authority, South Carolina Coastal Conservation League, Savannah Riverkeeper, and South Carolina Wildlife Federation, Savannah River Maritime Commission (SRMC) and the South Carolina Department of Health & Environmental Control (DHEC).

Goal/Target: Install oxygenation system to mitigate dissolved oxygen impacts of the SHEP.

Progress: The USACE has agreed to install and evaluate a "Speece Cone" oxygen injection system (Tetra Tech 2010) prior to commencement of dredging activities on the inner harbor. The final settlement agreement (USACE 2013) states the oxygen injection system must be operated and instream dissolved oxygen must be monitored continuously for a period of 59 days (2 lunar cycles). Continuous daily water quality monitoring must be conducted during this period at specified locations. If the Corps determines that the oxygen injection system test meets "success criteria", it will commence inner harbor channel dredging. Following the installation of the entire oxygen injection system, a second analysis will be completed for a "start-up run". The second round of testing will follow very similar protocols to the initial evaluation, but stipulates that at least one 29.5 day testing period (one lunar cycle) must occur in July, August, or September immediately following the installation of the oxygen injection system.

Following both the test run and "start-up run" the USACE, conservation groups, SRMC and DHEC each will independently evaluate the results report and other relevant

information to assess achievement of "success criteria". DHEC, SRMC, and the conservation groups each reserves the right to take any appropriate action if its independent determination is that the "success criteria" has not been met, including but not limited to suspension, rescission, and revocation of the state approvals, initiation of an enforcement or other legal action, and/or termination of this agreement. The USACE does not waive any objection or defense to such actions, including any objection or defense based on federal preemption, sovereign immunity, or immunity from state regulation.

Cost: $16,000,000

Timeline: Dependent upon funding

Action 2: Develop a TMDL implementation plan.

Regulatory Agencies/Contacts: GADNR-Georgia Environmental Protection Division (GAEPD), Wildlife Resources Division (WRD), and Coastal Resources Division (CRD), USFWS, NMFS, USACE, Federal Energy Regulatory Commission (FERC), US EPD, federal and state legislators, and local municipalities

Goal/Target: Reduce organic loads to sustain acceptable DO levels.

Progress: The Savannah River and Harbor have been extensively studied over the last ten years and a TMDL has been proposed for DO. The Savannah River and Harbor TMDL indicates a need for substantial reductions in organic loads for all dischargers from Augusta to the harbor (GAEPD 2011). Groups from South Carolina and Georgia representing the Central Savannah River Area (CSRA) as well as harbor dischargers have been tasked to develop a TMDL implementation plan.

Cost: Unknown

Timeline: Unknown

Salinity-Dredging/deepening the Savannah Harbor has altered salinity levels in the lower Savannah River and the current SHEP could exacerbate saltwater intrusion.

Action 1: Mitigate potential impacts of SHEP on salinity levels.

Regulatory Agencies/Contacts: The USFWS, NMFS, USACE, FERC, GADNR, SC DNR, Georgia Ports Authority, South Carolina Coastal Conservation League, Savannah

Riverkeeper, and South Carolina Wildlife Federation, Savannah River Maritime Commission (SRMC) and the South Carolina Department of Health & Environmental Control (DHEC).

Goal/Target: Develop and implement plans that would mitigate the effects of the SHEP on the salinity levels in the lower Savannah River.

Progress: USACE utilized models to determine appropriate measure to mitigate for salinity and tidal wetland impacts. Mitigation plans call for series of actions that include a diversion structure, closure of cuts, filling a sediment basin, and removal of tide gate abutments and piers (Tetra Tech 2010). While these plans do not fully mitigate for all impacts, they are expected to provide substantial benefits to the fresh water marsh ecosystems by providing additional fresh water flows to the Back River System and will limit saltwater intrusion to the Back River area.

Cost: Unknown

Timeline: Unknown

Detailed information concerning the SHEP project can be found at the following website: http://www.sas.usace.army.mil/Missions/CivilWorks/SavannahHarborExpansion.aspx

e. Land use inventory and assessment-none

f. Atmospheric deposition assessment

Atmospheric deposition is measured as a cooperative effort between many different groups, including federal, state, tribal and local governmental agencies, educational institutions, private companies, and non-governmental agencies as part of the National Atmospheric Deposition Program (NADP). This organization uses many networks (NTN, AIRMoN, MDN, AMNet, and AMNoN) to monitor methyl mercury, ammonia, etc. Detailed information concerning atmospheric deposition in SC can be found at the following website: http://nadp.sws.uiuc.edu/data/annualmaps.aspx

It does not appear that current levels of atmospheric deposition are impacting American shad migrations or utilization of historic habitat.

g. Climate change assessment

A changing climate will present water-related challenges for American shad in several areas including: water quality, water quantity and changes in sea level. Current climate models predict

continued warming across the southeast, with the greatest temperature increases projected in summer. Average annual temperatures are projected to rise 4.5°F by the 2080s under a lower emissions scenario and 9°F under a higher emissions scenario with a 10.5°F increase in summer. The frequency, duration and intensity of droughts are likely to continue to increase with higher average temperatures and a higher rate of evapotranspiration. Drought conditions could potentially impact American shad recruitment and long duration drought could negatively impact multiple year classes. Sea level rise is of concern because of the expected change in location of the saltwater/freshwater interface. As sea level rises, saltwater will move further up the river systems of the state thus reducing the amount freshwater spawning habitat available. The amount and distribution of aquatic vegetation also will change in response to increases in salinity, limiting cover and food sources for aquatic organisms. A changing climate will impact the water resources of South Carolina and will present challenges for American shad management.

Action: Develop a climate change plan.

Regulatory Agencies/Contacts: SC Department of Natural Resources (SCDNR)

Goal/Target: Establish recommendations to address climate change.

Progress: A "draft" plan has been developed and is still under review. It can be accessed at the following weblink:

http://www.dnr.sc.gov/pubs/CCINatResReport.pdf

Cost: Unknown at this time.

Timeline: Unknown

h. Competition and predation by invasive and managed species assessment

Aquatic invasive species occur throughout South Carolina's coastal rivers, and non-native ictalurids are some of the most ubiquitous invasive species. Flathead catfish (*Pylodictis olivaris*) and blue catfish (*Ictalurus furcatus*) were introduced into South Carolina in 1964 and are now found in all of South Carolina's coastal rivers. A significant portion of blue catfish and especially flathead catfish diet is comprised of fish, and due to their large adult size (>60 lbs) they have the potential to consume both adult and juvenile American shad. Ictalurid population information is currently unavailable for South Carolina's coastal rivers; however current studies are occurring in South Carolina and other neighboring states to assess the potential impacts of non-native catfish on American shad.

Action: Develop an invasive species plan.

Regulatory Agencies/Contacts: SCDNR and GADNR

Goal/Target: Establish recommendations to address invasive species.

Progress: SCDNR programs are currently monitoring catch rates of invasive catfish as part of non-targeting sampling and any flat head catfish captured during these activities are being removed from the system. In addition, current eradication programs, such as those that occurred on the Satilla River, GA, are being reviewed by SCDNR staff to determine if such programs are feasible for SC Rivers.

GA DNR completed experimental electro-fishing removals of flathead catfish from the Altamaha River system during the 1990s in an effort to restore native fish redbreast sunfish and bullhead spp populations that had been adversely impacted. These efforts were discontinued due to the large nature of the river, budget reductions, and shifts in angler attitudes. Current practices in the Satilla River have been reviewed to assess the feasibility of such programs for GA Rivers, including the Savannah and Ogeechee rivers. While GA DNR staff have thus far not initiated efforts to remove flatheads discovered in recent years in the Savannah due, in part, to the size and depth of the river, GA DNR staff have developed a response plan to address any potential introductions that may occur in the nearby Ogeechee River, a smaller coastal blackwater river just south of Savannah. Additionally, GA DNR has developed a Statewide Aquatic Nuisance Species Management Plan, which can be found at https://georgiawildlife.com/sites/default/files/wrd/pdf/management/ANSPlan_Final_rev.pdf.

Cost: Unknown at this time.

Timeline: Unknown

Final Thoughts (As Recommended and Supported by the TC)

The 2020 Atlantic States Marine Fisheries Commission's American Shad Stock Assessment and Peer Review Report provides an extensive review of available literature and discussion on the topic of fish passage (ASMFC 2020). Specifically, it highlights the issues with lack of evaluation and performance from decades-old approaches, facilities designs/operations that are not effective, and therefore cannot reasonably be expected to achieve management and restoration goals without significant changes. The Assessment Report also provides an important quantitative modeling approach examining shad habitat and passage barriers, and the need to address status quo fish passage performance. The impacts of these barriers and status quo passage are described and also modeled as effects on spawner population size under three scenarios, 1) no barriers, 2) first barrier with no passage, and 3) realistic fish passage performance measures applied to barriers (e.g., upstream passage efficiency of 50%).

The Assessment Report used standardized data and modelling approaches that quantified the impacts of barriers and fish passage as significant in all three management areas examined based on shad life history and habitat (New England, Mid-Atlantic, and South Atlantic). The assessment determined that overall, dams completely or partly block nearly 40% of the total habitat once used by American Shad. The model results of the "no barriers" scenario yielded an estimated spawner production potential 1.7 times greater than that yielded by the scenario assuming no passage at the first barrier: 72.8 million versus 42.8 million fish. The results of the third model scenario, which applies "realistic" (i.e., current) fish passage efficiencies, resulted in a gain of less than 3 million fish. Conclusions include "losses in (spawner production) potential are significant in each state and region." The Assessment Report provides a strong justification for the need and benefits of requiring improved fish passage performance measures. Additionally, meeting such improved passage performance standards is now an achievable goal given the current state of knowledge on fish behavior, swimming performance, and fish passage engineering expertise.

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Georgia Department of Natural Resources
American Shad Habitat Plan

Submitted to the Atlantic States Marine Fisheries Commission as a requirement of Amendment 3 to the Interstate Management Plan for Shad and River Herring

Approved: February 6, 2014

Updated: December 2020

Altamaha River

Habitat Assessment

The Altamaha River is formed by the confluence of the Ocmulgee and Oconee rivers and flows approximately 220 km before emptying into the Atlantic Ocean near Darien, GA. Including its longest tributary (the Ocmulgee River), the Altamaha River runs for approximately 756 km, making it the seventh longest river in the U.S. that is entirely within one state. The Altamaha River drainage basin covers an area of approximately 36,000 km^2, with its headwaters arising near Atlanta, GA for the Ocmulgee River and near Athens, GA for the Oconee River. There are no dams directly on the Altamaha, though there are dams on both the Oconee and the Ocmulgee rivers. With no barriers directly on the Altamaha all historical estuarine habitat remains available to juvenile and migrating adult shad.

Historical evidence suggests that American shad once occurred in the Altamaha Basin at least as far upstream as the vicinity of Covington, GA in the Ocmulgee River Basin and near the city of Athens, GA in the Oconee River Basin [Bryson 1826; Baird 1884; Bill Frazier, U. S. Fish and Wildlife Service (retired), 2001, personal communication; Elizabeth Reitz, University of Georgia, 2007, personal communication]. However, the construction of dams has limited their migrations. Most of these structures are still in place and continue to serve as barriers to nearly 6,000 acres of potential riverine shad habitat.

American shad currently occur from the mouth of the Altamaha River to the East Juliette Hydroelectric Dam on the Ocmulgee River (approximately river km 570) and Sinclair Dam on the Oconee River (approximately river km 446). Approximately 70% of the historical riverine habitat currently remains available to migrating adult American shad.

Threats Assessment

1. **Migration Barriers**- Full utilization of all potential spawning habitat in the Altamaha River Basin could entail modification of several dams in the Oconee, Ocmulgee, and Ohoopee Basins, to facilitate fish passage.

   Action 1: Develop a plan for establishing fish passage at barriers in the Altamaha River system.

   Regulatory Agencies/Contacts: USFWS, NMFS, FERC, USACE, Georgia Department of Natural Resources (GA DNR), dam owners/operators, and federal and state legislators.

   Goal/Target: Establish fish passage at all dams in the Altamaha basin, where passage is determined to be feasible.

   Progress: GA DNR has developed an American shad restoration plan for the Altamaha River Basin, which includes the implementation of fishways as a restoration strategy. The

plan calls for utilizing Section 18 of the Federal Power Act, which provides the U.S. Departments of Commerce and Interior mandatory conditioning authority to prescribe fish passage during the Federal Energy Regulation Commission (FERC) licensing process for hydroelectric facilities. The FERC-licensed hydroelectric facilities in the Altamaha Basin that are within the historic range of the American shad should have fish passage provisions included in their upcoming licenses, when passage is determined to be feasible.

For FERC-licensed facilities that already have a spawning population directly below them (e.g., East Juliette Hydroelectric Dam, Sinclair Dam), fish passage should be evaluated and implemented as soon as feasible (or upon FERC relicensing). For all other FERC-licensed facilities, fish passage should be provided in a stepwise fashion upon the establishment of spawning runs directly below these structures (upon fish passage at all downstream structures).

For non-FERC-licensed dams, resource agencies should work with owners to explore passage opportunities such as fishways, breaching, or removal. Where feasible, obsolete or non-functioning barriers to migration should be removed or breached.

Progress has been made in recent years regarding re-establishing fish passage and improving habitat. One such example is the removal of the White Dam on the Middle Oconee River near Athens, GA in 2018.

East Juliette Hydroelectric Dam

A fish passage prescription for East Juliette Hydroelectric dam has been completed. However, negotiations between the Services and project operator are still ongoing and construction of the fishway has not been initiated.

Cost: Unknown

Timeline: Unknown

Action 2: Potentially conduct experimental trap and transport operations.

Regulatory Agencies/Contacts: GA DNR, ASMFC, USFWS, NMFS, FERC, USACE, dam owners and operators, and federal and state legislators.

Goal/Target: Assess of upstream migratory behavior and level of passage at partial barriers and to provide access to additional spawning habitat that may be more suitable than that available below downstream barriers.

Progress: Experimental trap and transport operations are listed as a potential method for assessing migratory behavior, partial barrier passage, and allow for potential spawning at previously unavailable habitat. GA DNR has no immediate plans to initiate trap and transport activities at this time.

Cost: Unknown

Timeline: Unknown

2. **Dissolved Oxygen**- Though no dissolved oxygen issues have been identified within the Altamaha River itself, segments of tributary rivers and streams have been identified as not having sufficient assimilative capacity to maintain dissolved oxygen levels of 5mg/L or greater at maximum permitted discharge levels under low flow conditions.

Action 1: Develop a regional water plan that recommends appropriate water management practices to ensure healthy aquatic ecosystems.

Regulatory Agencies/Contacts: GA DNR-Environmental Protection Division (EPD), Wildlife Resources Division (WRD), and Coastal Resources Division (CRD), state legislators, and local municipalities

Goal/Target: Ensure water quantity remains adequate to support all life stages of American shad and other aquatic organisms in the Altamaha River.

Progress: In 2008, the Georgia General Assembly, as part of the Statewide Comprehensive Water Management Plan, established 10 regional water planning councils that encompassed the 14 major river systems within Georgia. With technical guidance from GA EPD, these councils were tasked with developing regional water plans that outlined management practices to meet future water needs for both water quantity and water quality through 2050. In November 2011, the ten regional water plans were officially adopted by GA EPD.

The Altamaha Council recommended a suite of surface water quality management practices in a phased approach to address water quality issues, including stream segments with limited localized dissolved oxygen assimilative capacity and insufficient wastewater permit capacity (GA EPD 2011a). These recommendations include such practices as the additional sustainable development of groundwater and surface water in areas with sufficient water supply; best management practices for water quality issues such as non-point source runoff, nutrient loadings, and TMDLs in the region; and additional educational and ordinance practices.

For the Altamaha Region, 75 impaired stream reaches (total impaired length of 915 miles) and 2 impaired lakes (total impaired area of 390 acres) have been identified. The majority of impairments are due to low dissolved oxygen and fecal coliform. Total maximum daily loads have been completed for 71 of the impaired stream reaches and for both of the impaired lakes.

Cost: Unknown

Timeline: Regional water plan extends through 2050

3. **Competition and Predation by Invasive Species-** Flathead catfish and blue catfish have been introduced into that Altamaha River system through unauthorized stockings. A significant portion of both flathead catfish and blue catfish diets are comprised of fish, and due to their large adult size (>60 lbs) they have the potential to consume both adult and juvenile American shad. Flathead catfish were first documented in the Ocmulgee River in the early-1970's and have now colonized the entire Altamaha River system. Abundance of flathead catfish rapidly expanded from approximately 1980 through the late-1990's. Electrofishing catch rates by weight peaked at 274 kg/hr in 1993 and by number at 108 fish/hr in 2004. Since 2000, electrofishing catch rates have ranged from 43-135 fish/hr, having a CPUE of 111.97 fish/hr in 2020. The average size of the flathead catfish in the Altamaha River peaked at approximately 3.5 kg in the mid-1990's and has since decreased to approximately 1 kg. A diet analysis of flathead catfish was completed during the months of June-September of 1997 and found the dominant prey items to be centrarchid spp. and ictalurid spp (Weller and Robbins, 2001). No Alosa spp. were identified in the stomach of flathead catfish during this study, but consumed juvenile American and/or hickory shad could have been unidentifiable due to extensive digestion.

   Blue catfish were first detected in the Altamaha River in 2006 and their abundance has steadily increased. In 2011, blue catfish electrofishing CPUE was 29 fish/hr, and in 2020 blue catfish CPUE was 63 fish/hr. It is expected that the abundance of this species will continue to increase for several more years. Stomach contents of 257 blue catfish were analyzed in the summer of 2010 and it was found that Alosa spp. comprised 0.4% by number of prey items consumed (Bonvechio et al. 2012). The majority of the blue catfish in this study were relatively small (59.5% < 300 mm) so as larger blue catfish become more abundant utilization of Alosa spp as a prey item may increase.

   ***Action 1*:** Management of invasive catfish species.

   Regulatory Agencies/Contacts: GA DNR

   Progress: GA DNR completed experimental electrofishing removals of flathead catfish from the Altamaha River system during the 1990s in an effort to restore native fish redbreast sunfish and bullhead *spp* populations that had been adversely impacted. These efforts were discontinued due to the large nature of the river, budget reductions, and shifts in angler attitudes.

   Cost: Unknown

   Timeline: Discontinued

Ogeechee River

Habitat Assessment

The Ogeechee River originates in the Georgia piedmont and flows for approximately 425 km while crossing the fall line, sandhill region, and the coast plain before emptying into the Atlantic Ocean in Ossabaw Sound. The Ogeechee River watershed encompasses approximately 14,300 km^2. Tidal influence typically extends to rkm 72 and the fresh/saltwater interface occurs approximately 56 km upstream from the mouth of the river. No manmade barriers are present the entire length of the Ogeechee River, so all historical riverine and estuarine habitats remain available to juvenile and migrating adult American shad.

Threats Assessment

1. **Instream Flow**- The Georgia Environmental Protection Division (EPD) conducted resource assessments to predict resource conditions based on projection population growth and resulting water demands through 2050. Based on these predictions peak season agricultural irrigation may result in potential in-stream flow shortages in the Ogeechee Basin (GA EPD 2011b). The stream flow may fall below the in-stream flow target during summer low flow periods after meeting upstream irrigation needs.

   Action 1: Develop a regional water plan that recommends appropriate water management practices to ensure healthy aquatic ecosystems.

   Regulatory Agencies/Contacts: GA DNR-EPD/WRD/CRD, USFWS, NMFS, FERC, US EPD, USACE, federal and state legislators, and local municipalities.

   Goal/Target: Ensure water quantity remains adequate to support all life stages of American shad and other aquatic organisms in the Ogeechee River.

   Progress: In 2008, the Georgia General Assembly, as part of the Statewide Comprehensive Water Management Plan, established 10 regional water planning councils that encompassed the 14 major river systems within Georgia. With technical guidance from GA EPD, these councils were tasked with developing regional water plans that outlined management practices to meet future water needs for both water quantity and water quality through 2050. In November 2011, the ten regional water plans were officially adopted by GA EPD.

   To prevent potential shortages in meeting in-stream flow needs, the plan encompassing the Ogeechee River calls for more aggressive water conservation practices and development of drought management practices for the agricultural users/permittees in the Upper Ogeechee River Basin (GA EPD 2011b). The Council also recommends in-stream flow studies (to determine what flow levels are appropriate for protecting aquatic life) and additional stream flow monitoring in the Ogeechee River Basin (to confirm the frequency and magnitude of predicted in-stream flow shortages).

Cost: Unknown

Timeline: Regional water plan extends through 2050

2. **Point Source Discharges-** In May 2011, the Ogeechee River experienced a large-scale fish kill that affected multiple species including American shad. The upper extent of the kill was below the only industrial discharge above the kill area.

   Action 1: Develop and implement permits and monitoring to avoid future fish kills.

   Regulatory Agencies/Contacts: GA DNR-EPD/WRD, US EPD, and appropriate private industrial operators.

   Goal/Target: Ensure water quality remains adequate to support all life stages of American shad and other aquatic organisms in the Ogeechee River.

   Progress: After the 2011 fish kill, GA EPD reviewed and revised the existing discharge permit for King America Finishing in attempt to prevent future fish kills related to their discharge. GA EPD has since closely monitored water quality in this area of the Ogeechee River.

   Cost: Unknown

   Timeline: Currently ongoing

Satilla River

Habitat Assessment

The Satilla River originates in Ben Hill County near the town of Fitzgerald, GA and flows for approximately 378 km before emptying into the Atlantic Ocean in St. Andrews Sound. The Satilla River watershed encompasses approximately 10,000 km^2 of Georgia's coastal plain. Tidal influence typically extends to rkm 93 and the fresh/saltwater interface occurs approximately 32 km upstream from the mouth of the river. No manmade barriers are present the entire length of the Satilla River, so all historical riverine and estuarine habitats remain available to juvenile and migrating adult American shad.

Threats Assessment

1. **Competition and Predation by Invasive Species**-Flathead catfish were introduced into that Satilla River system through unauthorized stockings in the mid-1990s and blue catfish were collected by GA DNR in 2012. A significant portion of flathead catfish diets

are comprised of fish, and due to their potential large adult size (>100 lbs) they have the potential to consume both adult and juvenile American shad.

***Action 1*:** Management of invasive catfish species.

Regulatory Agencies/Contacts: GA DNR

Progress: GA DNR initiated electrofishing removals of flathead catfish from the Satilla River in 1996 with existing manpower and funding in an effort to preserve native fish species, specifically redbreast sunfish and bullhead spp. Flathead abundance continued to increase despite these efforts, which were limited due to manpower and fiscal limitations. Native fish populations were also showing early signs of decline. In 2006, Georgia's legislature appropriated funding for dedicated positions and equipment to conduct extensive flathead catfish removal efforts on the Satilla River. Since 2007, approximately 82,000 flathead catfish weighing over 163,000 lbs have been removed from the Satilla River. Over time, these efforts have resulted in a significant reduction in the flathead catfish biomass and appear to be preserving the abundance of native species.

Blue catfish were first observed in the river in 2010, with only a few individuals being collected in the first few years. In 2016, abundance dramatically rose when 224 blue catfish were captured during electrofishing efforts. Subsequent years (2017=397; 2018=58; 2019=663; 2020=187) continued to produce several fish. GA DNR suspects that these fish may have colonized the Satilla River from the Altamaha River via the intercostal water way during a high flow period, due to their relatively high tolerance to brackish water.

Cost: Unknown

Timeline: Ongoing

2. **Dissolved Oxygen-** Dissolved oxygen levels below 3 mg/L occur during low flow events in the months of July-September in an approximately a 30 km segment of the tidally influenced portion of the Satilla River. The Satilla River naturally has a low assimilative capacity and resulting low DO levels during summer low flow periods, therefore it may not be possible to maintain DO levels above 3 mg/L at all times. However, the actions listed below will still be beneficial.

***Action 1*:** Develop a TMDL implementation plan.

Regulatory Agencies/Contacts: GA DNR-EPD/WRD/CRD, state legislators, and local municipalities

Goal/Target: Reduce organic loads to sustain acceptable DO levels.

Progress: GA DNR worked with representatives of local municipalities and conservation groups and developed a TMDL implementation plan that included a suite of

management measure to reduce organic carbon, Total Nitrogen, and Total Phosphorous inputs in order to improve dissolved oxygen levels in the Satilla River.

Cost: Unknown

Timeline: Unknown

***Action 2*:** Develop a regional water plan that recommends appropriate water management practices to ensure healthy aquatic ecosystems.

Regulatory Agencies/Contacts: GA DNR-EPD/WRD/CRD, USFWS, NMFS, FERC, US EPD, USACE, federal and state legislators, and local municipalities.

Goal/Target: Ensure water quantity remains adequate to support all life stages of American shad and other aquatic organisms in the Satilla River.

Progress: In 2008, the Georgia General Assembly, as part of the Statewide Comprehensive Water Management Plan, established 10 regional water planning councils that encompassed the 14 major river systems within Georgia. With technical guidance from GA EPD, these councils were tasked with developing regional water plans that outlined management practices to meet future water needs for both water quantity and water quality through 2050. In November 2011, the ten regional water plans were officially adopted by GA EPD.

The Suwannee-Satilla-St Mary's Council recommended a suite of surface water quality management practices in a phased approach to address water quality gaps, including stream segments with limited localized dissolved oxygen assimilative capacity and insufficient wastewater permit capacity (GA EPD 2011c). Specific actions to add/improve infrastructure and improve flow and water quality conditions were identified and recommended. These include such practices as the additional sustainable development of groundwater and surface water in areas with sufficient water supply; best management practices for water quality issues such as non-point source runoff, nutrient loadings, and TMDLs in the region; and additional educational and ordinance practices.

Cost: Unknown

Timeline: Regional water plan extends through 2050

3. **Instream Flow-** The Georgia EPD conducted resource assessments on current and predicted resource conditions based on projected population growth and resulting water demands through 2050. These assessments concluded that instream flow shortages were present under current and future demands in portions of the Satilla Basin.

Action 1: Develop a regional water plan that recommends appropriate water management practices to ensure healthy aquatic ecosystems.

Regulatory Agencies/Contacts: GA DNR-EPD/WRD/CRD, USFWS, NMFS, FERC, US EPD, USACE, federal and state legislators, and local municipalities.

Goal/Target: Ensure water quantity remains adequate to support all life stages of American shad and other aquatic organisms in the Satilla River.

Progress: The Satilla River water management plan was officially adopted by GA EPD in November 2011 and recommended a suite of management practices, including those that reduce net consumption, replace surface water use with groundwater use, and improve data on frequency and magnitude of gaps (GA EPD 2011c).

Cost: Unknown

Timeline: Regional water plan extends through 2050

St. Mary's River

Habitat Assessment

The St. Mary's River originates in the Okefenokee Swamp and flows for approximately 203 km before emptying into the Atlantic Ocean in Cumberland Sound while forming the eastern portion of the border between Florida and Georgia. The St. Mary's watershed encompasses approximately 3,350 km^2 of which 59% is in Georgia and 41% in Florida. Tidal influence typically extends to rkm 88 and the fresh/saltwater interface occurs approximately 33 km upstream from the mouth of the river. No manmade barriers are present the entire length of the St. Mary's River, so all historical riverine and estuarine habitats remain available to juvenile and migrating adult American shad.

Threats Assessment

1. **Dissolved Oxygen-** Dissolved oxygen levels below 3 mg/L occur during low flow events in the months of July-September months of July-September in an approximately a 40 km segment of the tidally influenced portion of the St. Mary's River. The St Mary's River naturally has a low assimilative capacity and resulting low DO levels during summer low flow periods, therefore it may not be possible to maintain DO levels above 3 mg/L at all times. However, the actions listed below will still be beneficial.

***Action 1*:** Develop a TMDL implementation plan.

Regulatory Agencies/Contacts: Georgia Department of Natural Resources (GA DNR)-Environmental Protection Division (EPD), Wildlife Resources Division (WRD), and Coastal Resources Division (CRD), FL FWC, FL DEP, St. Johns Water Management District, state legislators, and local municipalities

Goal/Target: Reduce organic loads to sustain acceptable DO levels.

Progress: GA DNR worked with representatives of local municipalities and conservation groups and developed a TMDL implementation plan that included a suite of management measure to reduce organic inputs in order to improve dissolved oxygen levels in the St. Mary's River.

Cost: Unknown

Timeline: Unknown

Action 2: Develop a regional water plan that recommends appropriate water management practices to ensure healthy aquatic ecosystems.

Regulatory Agencies/Contacts: GA DNR-EPD/WRD/CRD, USFWS, NMFS, FERC, US EPD, USACE, federal and state legislators, and local municipalities.

Goal/Target: Ensure water quantity remains adequate to support all life stages of American shad and other aquatic organisms in the St. Mary's River.

Progress: In 2008, the Georgia General Assembly, as part of the Statewide Comprehensive Water Management Plan, established 10 regional water planning councils that encompassed the 14 major river systems within Georgia. With technical guidance from GA EPD, these councils were tasked with developing regional water plans that outlined management practices to meet future water needs for both water quantity and water quality through 2050. All 10 regional water plans were officially adopted in 2011.

The Suwannee-Satilla-St Mary's Council recommended a suite of surface water quality management practices in a phased approach to address water quality gaps, including stream segments with limited localized dissolved oxygen assimilative capacity and insufficient wastewater permit capacity (GA EPD 2011c). Specific actions to add/improve infrastructure and improve flow and water quality conditions were identified and recommended. These include such practices as the additional sustainable development of groundwater and surface water in areas with sufficient water supply; best management practices for water quality issues such as non-point source runoff, nutrient loadings, and TMDLs in the region; and additional educational and ordinance practices.

Cost: Unknown

Timeline: Regional water plan extends through 2050

Final Thoughts (As Recommended and Supported by the TC)

The 2020 Atlantic States Marine Fisheries Commission's American Shad Stock Assessment and Peer Review Report provides an extensive review of available literature and discussion on the topic of fish passage (ASMFC 2020). Specifically, it highlights the issues with lack of evaluation and performance from decades-old approaches, facilities designs/operations that are not effective, and therefore cannot reasonably be expected to achieve management and restoration goals without significant changes. The Assessment Report also provides an important quantitative modeling approach examining shad habitat and passage barriers, and the need to address status quo fish passage performance. The impacts of these barriers and status quo passage are described and also modeled as effects on spawner population size under three scenarios, 1) no barriers, 2) first barrier with no passage, and 3) realistic fish passage performance measures applied to barriers (e.g., upstream passage efficiency of 50%).

The Assessment Report used standardized data and modelling approaches that quantified the impacts of barriers and fish passage as significant in all three management areas examined based on shad life history and habitat (New England, Mid-Atlantic, and South Atlantic). The assessment determined that overall, dams completely or partly block nearly 40% of the total habitat once used by American Shad. The model results of the "no barriers" scenario yielded an estimated spawner production potential 1.7 times greater than that yielded by the scenario assuming no passage at the first barrier: 72.8 million versus 42.8 million fish. The results of the third model scenario, which applies "realistic" (i.e., current) fish passage efficiencies, resulted in a gain of less than 3 million fish. Conclusions include "losses in (spawner production) potential are significant in each state and region." The Assessment Report provides a strong justification for the need and benefits of requiring improved fish passage performance measures. Additionally, meeting such improved passage performance standards is now an achievable goal given the current state of knowledge on fish behavior, swimming performance, and fish passage engineering expertise.

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DRAFT FOR BOARD REVIEW

REVIEW OF THE ATLANTIC STATES MARINE FISHERIES COMMISSION FISHERY MANAGEMENT PLAN FOR SHAD AND RIVER HERRING *(Alosa spp.)* FOR THE 2019 FISHING YEAR

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DRAFT FOR BOARD REVIEW

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 (PRFC) 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 first FMPs developed by 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 May 2009, the Board approved 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 harvest in state waters beginning January 1, 2012, unless a state or jurisdiction has a sustainable fishery management plan (SFMP) 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." Catch and release only fisheries may be maintained in any river system without an SFMP. SFMPs have been approved by the Management Board for Maine, New Hampshire, Massachusetts, New York, and South Carolina (Table 1). Amendment 2 also required states to implement fishery-dependent and independent

monitoring programs.

In February 2010, the Board approved 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 for shad as developed in Amendment 2 (for river herring). Specifically, Amendment 3 prohibits shad commercial and recreational harvest in state waters beginning January 1, 2013, unless a state or jurisdiction has a SFMP 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." Catch and release only fisheries may be maintained in any river system without an SFMP. SFMPs have been approved by the Board for Massachusetts, Connecticut, the Delaware River Basin Fish Cooperative (on behalf of New York, Delaware, New Jersey, and Pennsylvania), PRFC, North Carolina, South Carolina, Georgia, and Florida (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/jurisdictions with approved sustainable fishery management plans (SFMPs) for river herring or shad. Includes year of original Board approval and approved updates[1].

State	River Herring SFMP	Shad SFMP
Maine	Approved (2010, 2017, 2020)	Approved (2020)
New Hampshire	Approved (2011, 2015, 2020)	
Massachusetts	Approved (2016)	Approved (2012, 2019)
Connecticut		Approved (2012, 2017)
Rhode Island		
Pennsylvania		Approved* (2012, 2017, 2020)
New York	Approved (2011, 2017)	Approved* (2012, 2017, 2020)
New Jersey		Approved* (2012, 2017, 2020)
Delaware		Approved* (2012, 2017, 2020)
PRFC		Approved (2012, 2017)
Maryland		
Virginia		
North Carolina		Approved (2012, 2017, 2020)
South Carolina	Approved (2010, 2017, 2020)	Approved (2011, 2017, 2020)
Georgia		Approved (2012, 2017, 2020)
Florida		Approved (2011, 2017, 2020)

*The Delaware River Basin Fish and Wildlife Management Co-op has a Shad SFMP, 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 must 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 alewife) and two shads (American shad and hickory shad)—these are collectively referred to as shad and river herring, or SRH.

The most recent American Shad Benchmark Stock Assessment (ASMFC 2020) indicates American shad remain depleted on a coastwide basis. Multiple factors, such as overfishing, inadequate fish passage at dams, predation, pollution, water withdrawals, channelization of rivers, changing ocean conditions, and climate change are likely responsible for shad decline from historic abundance levels. Additionally, the assessment finds that shad recovery is limited by restricted access to spawning habitat. Current barriers partly or completely block 40% of historic shad spawning habitat, which may equate to a loss of more than a third of spawning adults.

Of the 23 river-specific stocks of American shad for which sufficient information was available, adult mortality was determined to be unsustainable for three stocks (Connecticut, Delaware, and Potomac) and sustainable for five stocks (Hudson, Rappahannock, York, Albemarle Sound, and Neuse). The terms “sustainable” and “unsustainable” were used instead of “not overfishing” and “overfishing” because fishing mortality cannot be separated from other components contributing to total mortality. The assessment was only able to determine abundance status for two stocks: abundance for the Hudson is depleted, and abundance for the Albemarle Sound is not overfished. For the Hudson and coastwide metapopulation, the “depleted” determination was used instead of “overfished” because the impact of fishing on American shad stocks cannot be separated from the impacts of all other factors responsible for changes in abundance.

The status of 15 additional stocks could not be determined due to data limitations, so trends in YOY and adult abundance were provided for information on abundance changes since the 2005 closure of the ocean-intercept fishery. For YOY indices, two systems experienced increasing trends while one system experienced a decreasing trend since 2005. All other systems experienced either no trend (eight systems), conflicting trends among indices (one system), or had no data (11 systems). For adult indices, four systems experienced increasing trends while no systems experienced decreasing trends since 2005. All other systems experienced either no trend (11 systems), conflicting trends among indices (seven systems), or had no data (one system). Trend analyses also indicate a continued lack of consistent increasing trends in coastwide metapopulation abundance since 2005.

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 efforts need to be identified and applied. Because multiple factors are likely responsible for shad decline, the recovery of American shad will need to address multiple factors including improved monitoring, anthropogenic habitat alterations, predation by non-native predators, and exploitation by fisheries. There are no coastwide reference points for American shad. There is no stock assessment available for hickory shad.

The most recent *River Herring Benchmark Assessment Report* (ASMFC 2012) indicated that 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 concluded that river herring remain depleted at near historic lows on a coastwide basis. Total mortality estimates over the final three years of the data time series (2013-2015) were generally high and exceed region-specific reference points for some rivers. However, some river systems showed positive signs of improvement. Total mortality estimates for 2 rivers fell below region-specific reference points during the final three 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 with available data, 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 the largest and most 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, today most harvest is believed to come from the commercial industry. Commercial landings for these species have declined dramatically from historic highs. Details on each fishery are provided below.

AMERICAN SHAD:

Total commercial landings throughout the 1950s fluctuated around 8 million pounds, then declined to just over two million pounds in 1976. A period of moderate increase occurred through the mid-1980s, followed by further declines through the remainder of the time series. Since the closure of the ocean intercept fishery in 2005, landings have been substantially lower, falling below one million pounds. Since 2015, landings have remained below half a million pounds.

The total commercial landings (directed and bycatch) reported in compliance reports from individual states and jurisdictions in 2019 were 273,450 pounds, representing a 4% decrease from landings in 2018 (285,523 pounds) (Table 2). Bycatch landings accounted for approximately 48% of the total commercial landings of American shad in 2019. Landings from South Carolina, North Carolina, and Georgia accounted for 31%, 29%, and 21% of the directed coastwide commercial fishery removals in 2019, respectively. The remainder of the directed

landings came from New Jersey, Connecticut, and Delaware. Maryland commercial fishermen are permitted a bycatch allowance of two fish per day of dead American shad for personal use, provided that shad are captured by gear legally deployed for the capture of other fish species; no sale is permitted. Landings from Virginia, District of Columbia, and PRFC are attributed to limited bycatch allowances for American Shad.

Substantial recreational shad fisheries occur on the Connecticut (CT and MA), Delaware (NY, PA NJ, and DE), Susquehanna (MD), Santee and Cooper (SC), 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. Though shad are recreationally targeted in these locations, many fisheries are catch and release only. Hook and line shad catch levels are not well understood; actual harvest and/or effort is only estimated by a few states through annual creel surveys (e.g. Maryland, North Carolina, Georgia, and Florida). Harvest may only amount to a small portion of total catch (landings and discards), but hooking mortality could increase total recreational fishery removals substantially.

Since 2009, recreational harvest data from the Marine Recreational Information Program (MRIP) are generally not provided for American shad due to high proportional standard errors (PSEs). This is a result of the MRIP survey design, which focuses on active fishing sites along coastal and estuarine areas and is unsuitable for capturing inland harvest. However, North Carolina and Florida reported American shad recreational harvest estimates for 2019 (Table 3).

HICKORY SHAD:
In 2019, North Carolina, South Carolina, and Georgia reported directed commercial hickory shad landings; Rhode Island, New York, New Jersey, Virginia, and North Carolina reported bycatch landings. North Carolina accounts for a vast majority of directed landings, contributing 90% of the total. Coastwide commercial and bycatch landings in 2019 totaled 143,851 pounds, representing a 48% increase from 2018 landings (97,284 pounds) (Table 2). Only North Carolina reported recreational harvest: 8,517 fish in 2019.

RIVER HERRING (BLUEBACK HERRING/ALEWIFE COMBINED):
Commercial landings of river herring declined 95% from over 13 million pounds in 1985 to about 733 thousand pounds in 2005. Recent commercial landings continue to increase, despite the closure of the ocean-intercept fishery in 2005 and North Carolina implementing a no-harvest provision for commercial and recreational fisheries of river herring in coastal waters of the state in 2007. In 2019, the coastwide directed commercial river herring landings reported in state compliance reports were 2.5 million pounds, an 11% increase from 2018 (2.3 million pounds). Landings including bycatch in 2019 totaled 3.2 million pounds, a 32% increase from the 2018 total of 2.45 million pounds (Table 2). Confidential data preclude reporting commercial landings by state. Maine, New Hampshire, and Massachusetts provided estimates of recreational river herring harvest in 2019 (Table 3).

Table 2. Shad and river herring total commercial fishery removals (directed landings and bycatch[1], in pounds) provided by states, jurisdictions and NOAA Fisheries for 2019.

	American Shad	Hickory Shad	River Herring
Maine	C	C	
New Hampshire	0	0	
Massachusetts	104,058	0	
Rhode Island	0	12,944	
Connecticut	5,596	C	
New York	1,581	C	
New Jersey	18,303	C	
Pennsylvania	0	0	
Delaware	2,404	0	
Maryland	0	0	
D.C.	0	0	
PRFC	17,454	0	
Virginia	3,821	414	
North Carolina	46,151	117,655	
South Carolina	43,290	C	
Georgia	30,356	12,104	
Florida	0	0	
Total Directed	140,920	124,091	2,502,011
Total Bycatch	132,530	19,760	720,111
Total	**273,450**	**143,851**	**3,222,122**

*All values for river herring by state are not shown due to confidential data. Confidential values by state for American shad and hickory shad are indicated by "C."

Table 3. Recreational harvest information for river herring and American shad in 2019 from MRIP and state compliance reports.

State	River Herring Harvest	American Shad Harvest	Source of Estimates
Maine	733.4 lbs		MRIP*
New Hampshire	17719.5 lbs		APAIS and mandatory-reporting for net and pot fishing
Massachusetts	2,090 fish		MRIP*
North Carolina		3,039 fish	Recreational creel surveys on the Roanoke, Tar, Neuse, and Cape Fear rivers
Florida		622 lbs	Access point creel survey on St. Johns River

*MRIP estimate considered highly uncertain, with a PSE of 90.8. Spatial coverage of MRIP sampling may not align with recreational harvest areas for shad. In Maine, only 3 shad were sampled in 2018 and fewer than 56 shad have been sampled since 1996.

IV. Status of Research and Monitoring

Amendment 2 (2009) and Amendment 3 (2010), required fishery-independent and fishery-dependent monitoring programs for select rivers. Juvenile abundance index (JAI) surveys, annual spawning stock surveys (Table 4), and hatchery evaluations are required for specified

[1] Available information on shad and river herring bycatch varies widely by state. Estimates may not capture all bycatch removals occurring in state waters.

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.

In addition to the mandatory monitoring requirements stipulated under Amendments 2 and 3, some states and jurisdictions continue important voluntary research initiatives for these species. For example, Massachusetts, Pennsylvania, Delaware, Maryland, District of Columbia, North Carolina, South Carolina, and the United States Fish and Wildlife Service (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 2019, several jurisdictions reared American shad, stocking a total of 11,964,361 American shad, a decrease of 47% from the 22,754,925 shad stocked in 2018 (Table 5). In addition 1,195,808 river herring (both alewife and blueback) larvae were stocked in Harrison Lake, part of the James River system, in 2019.

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 (Table 6).

Amendment 2 (2009) prohibits river herring commercial and recreational harvest in state waters beginning January 1, 2012, unless a state or jurisdiction submits a sustainable fishery management plan and receives approval from the Board. Amendment 3 (2010) also requires the development of a SFMP for any jurisdiction maintaining a shad commercial or recreational fishery after January 1, 2013 (with the exception of catch and release recreational fisheries). States are required to update SFMPs every five years. In 2017, states reviewed their SFMPs and made changes based on fishery performance or observations (e.g., revised sustainability targets) where necessary. At a minimum, states updated data for their commercial and/or recreational fisheries and recommended the current sustainability measures be carried forward in the next plan. To date the Board has reviewed and approved updated SFMPs for all states, with the updated Massachusetts SFMP for shad being approved in February 2019.

Under Amendments 2 and 3 to the FMP, states may implement, with Board approval, alternative management programs for river herring and shad that differ from those required by the FMP. States and jurisdictions must demonstrate that the proposed management program will not contribute to overfishing of the resource or inhibit restoration of the resource. The Management Board can approve a proposed alternative management program if the state or jurisdiction can show to the Management Board’s satisfaction that the alternative proposal will have the same conservation value as the measures contained in the FMP. In August 2020, the Board approved alternative management plans for recreational fishery regulations in South Carolina, Georgia, and Florida.

Table 4. American shad and river herring passage counts at select rivers along the Atlantic coast in 2019.

State/River	Shad	River Herring
Maine		
Androscoggin	63	81,025
Saco	1,139	55,028
Kennebec	44	240,594
Sebasticook	114	3,287,702*
Penobscot	2,489	1,986,910
St. Croix		486,500
New Hampshire		
Cocheco	0	1,682
Exeter	0	28
Oyster	0	4,969
Lamprey	0	34,684
Winnicut	0	0
Massachusetts		
Merrimack	18,653	143,541
Rhode Island		
Gilbert Stuart	0	35,832
Nonquit	0	101,714
Buckeye Brook	0	38,418
Connecticut River		
Holyoke Dam	314,361	5,052
Pennsylvania		
Schuylkill (Fairmont Dam)	415	
Pennsylvania/Maryland/Delaware		
Susquehanna (Conowingo)**	4,787	15
Susquehanna (Holtwood)**	570	
Susquehanna (Safe Harbor)**	316	
South Carolina		
St. Stephen Dam	95,788	39,938
Total 2019	437,853	6,543,632
Total 2018	642,688	9,404,020
Total 2017	761,386	5,876,375
Total 2016	540,917	5,514,890
Total 2015	611,368	3,825,435

*Passage after harvest removals.

**Passage numbers on Susquehanna River are cumulative and listed in ascending order of passage mile with Conowingo being nearest the river's mouth.

Table 5. Stocking of Hatchery-Cultured Alosine Larvae (Fry) in State Waters, 2019.

State	American Shad	River Herring
New Hampshire		
Lamprey River	2,829,219	
Massachusetts		
Merrimack River	271,155	
Nashua River	323,442	
Rhode Island		
Pawcatuck River	0	
Pawtuxet River	0	
Pennsylvania		
Susquehanna River	832,000	
Lehigh River	0	
Schuykill River	0	
Delaware		
Nanticoke River	858,000	
Maryland		
Choptank River	2,805,000	
District of Columbia/PRFC		
Potomac River**	9,500	
Virginia		
James River	0	1,195,808
North Carolina		
Neuse River	0	
Roanoke River	0	
South Carolina		
Edisto River	28,799	
Wateree River	4,007,246	
Georgia		
Altamaha River	0	
Oconee River	0	
Total	**11,964,361**	**1,195,808**

*In Maine and Massachusetts river herring of wild origin are stocked as adult pre-spawning individuals through trap and transfer programs. These are not counted toward the total because they are not of hatchery origin.
**Numbers of fry stocked from combined efforts of PRFC, DC, and MD.

VI. Prioritized Research Needs

Due to the large number of research recommendations identified during stock assessments of these alosine species, only research recommendations identified as high priority are presented below. Recommendations are categorized by the expected time frame necessary to complete the recommendation (short term vs. long term). See the most recent benchmark stock assessment of each species (2020 for American shad, 2012 for blueback herring and alewife) for additional important research recommendations.

AMERICAN SHAD

Short Term

- Otoliths should be collected as the preferred age structure. If collection of otoliths presents perceived impact to conservation of the stock, an annual subsample of paired otolith and scales (at least 100 samples if possible) should be collected to quantify error between structures.
- Error between structures, if scales are the primary age structure collected, and for spawn mark count estimates (either between multiple readers or within reader) should be quantified on an annual basis. A mean coefficient of variation (CV) of 5% and detection of no systematic bias should serve as targets for comparisons.
- Two readers should determine consensus ages and spawn mark counts based on improvements in ageing error in the Delaware system when consensus-based estimates were part of the ageing protocol.

Long Term

- Develop a centralized repository for agencies to submit and store genetic sampling data for future analysis. The Atlantic sturgeon repository at the United States Geological Survey (USGS) Leetown Science Center should serve as an example.
- Collect genetic samples from young-of-year (YOY) and returning mature adults during spawning runs for future analysis of baseline genetic population structure and site fidelity/straying rates. These data will help define stock structure, identify stock composition from genetic sampling of American shad catch in mixed-stock fisheries, and provide information on recolonization capabilities in defunct American shad systems.
- Conduct annual stock composition sampling through existing and new observer programs from all mixed-stock fisheries (bycatch and directed). Potential methods include tagging (conventional external tags or acoustic tags) of discarded catch and genetic sampling of retained and discarded catch. Mortality rates of juvenile fish in all systems remain unknown and improvement in advice from future stock assessments is not possible without this monitoring. Known fisheries include the Delaware Bay mixed-stock fishery and all fisheries operating in the Atlantic Ocean (U.S. and Canada) that encounter American shad (see Section 4.1.4 in the stock assessment report).
- Implement fishery-independent YOY and spawning run surveys in all systems with open fisheries. Surveys should collect catch rates, length, individual weight, sex (spawning runs), and age (spawning runs) data at a minimum to allow for assessment of stocks with legal harvest. Require these surveys be in operation in systems with requested fisheries before opening fisheries.

- Conduct complete in-river catch monitoring in all systems with open fisheries. Monitoring programs should collect total catch, effort, size, individual weight, and age data at a minimum. Require these surveys be in operation in systems with requested fisheries before opening fisheries.
- Conduct maturity studies designed to accommodate the unique challenges American shad reproductive behavior (i.e., segregating by maturity status during spawning runs) poses on traditional monitoring programs. This information will also improve understanding of selectivity by in-river fisheries and monitoring programs.
- Conduct fish passage research at barriers with adults for both upstream and downstream migration and movements and with juveniles for downstream as discussed in Section 1.1.9.5 of the stock assessment report.

RIVER HERRING

Short Term

- Analyze the consequences of interactions between the offshore bycatch fishery and population trends in the rivers.
- Continue genetic analyses to determine population stock structure along the coast and enable determination of river origin of incidental catch in non-targeted ocean fisheries.
- Continue to assess current ageing techniques for river herring, using known-age fish, scales, otoliths, and spawning marks.
- Improve reporting of harvest by waterbody and gear.
- Develop and implement monitoring protocols and analyses to determine river herring population responses and targets for rivers undergoing restoration (dam removals, fishways, supplemental stocking, etc.).
- Explore the sources of and provide better estimates of incidental catch in order to reduce uncertainty in incidental catch estimates.

Long Term

- Encourage studies to quantify and improve fish passage efficiency and support the implementation of standard practices.
- Determine and quantify which stocks are impacted by mixed stock fisheries (including bycatch fisheries). Methods to be considered could include otolith microchemistry, oxytetracycline otolith marking, genetic analysis, and/or tagging.
- Validate [better estimate] the different values of natural mortality (*M*) for river herring stocks and improve methods for calculating *M*.
- Conduct biannual ageing workshops to maintain consistency and accuracy in ageing fish sampled in state programs.
- Investigate the relation between juvenile river herring production 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.
- Expand observer and port sampling coverage to quantify additional sources of mortality for alosine species, including bait fisheries, as well as rates of incidental catch in other fisheries.

VII. Status of Implementation of FMP Requirements

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 (PRT) reviewed all state reports for compliance with the mandatory measures in Amendments 2 (River Herring) and 3 (American shad). Table 6 provides important information on each state's fisheries, monitoring programs, and compliance issues pertaining to the 2019 fishing year. Table 7 summarizes state reports of protected species interactions.

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 2019:

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

State Compliance

All states with a declared interest in shad and river herring management have submitted annual compliance reports. Virginia has also submitted a separate bycatch report in accordance with the provisions of their limited bycatch program.

Most states have regulations in place that meet the intent of the requirements of the Interstate Fisheries Management Plan for Shad and River Herring. The PRT notes the following compliance issues encountered in their review of the state reports:

1. In 2019, several states allowed recreational harvest for shad and/or river herring in absence of an approved SFMP, though Amendments 2 and 3 require all states and jurisdictions to submit SFMPs for systems that remain open to commercial and recreational harvest. These issues have been resolved through the approval of the following plans:
    - Maine SFMP for American shad (2020)
    - South Carolina: Alternative Management Plan for river herring (2020)
    - Georgia: Alternative Management Plan for river herring (2020)
    - Florida: Alternative Management Plan for river herring in all state waters, and for American shad outside of the St. Johns system (2020)

2. Several states did not report on all monitoring requirements listed under Amendments 2 and 3 (see Table 6). A few states have consistently omitted the same information from compliance reports for the past few years (CT, NY, NC, GA). These states should take note of the required monitoring programs that were not reported and make a concerted effort to report all monitoring programs in future compliance reports. The most common omissions were: characterization of other losses, variance, characterization of recreational harvest, length and age frequency, and degree of repeat spawning.

3. Many states did not submit their monitoring data in a separate Excel file along with the compliance report, as is required by Amendment 3. If data from required monitoring is provided in a separate file, the compliance report should also indicate what data were provided.

VIII. PRT Recommendations

After a thorough review of the state reports, the PRT recommends approval of the state compliance reports for the 2019 fishing year and *de minimis* requests. In addition, the PRT recommends the Board consider changes to the annual compliance report format for shad and river herring. Over the last several years the PRT and Technical Committee have continued to express concerns with the difficulty of preparing and reviewing compliance reports that contain such a large quantity of information. To streamline this process while ensuring necessary information is still reported on an annual basis, the PRT recommends the following format for annual compliance reports:

I. Introduction

Briefly highlight any significant changes in monitoring, regulations, or harvest.

II. Request for *de minimis* (If applicable)

III. Harvest and Losses

Provide a table of harvest and losses for each species, including reported commercial landings, bycatch landings, poaching, recreational harvest, catch and release mortality, fish passage mortality, discarded males, brood stock capture, research losses, etc.

V. Previous year's fishery and management program

A. Include a copy of all current fishery regulations as an appendix to the report.

B. Completion of Required Monitoring: include, in table format a list of each required monitoring component (fishery-dependent and -independent), whether or not it was completed for the previous year, and any additional comments (e.g. explanation of incomplete monitoring, changes to monitoring program, data caveats, or other significant information). This table should NOT include results of each monitoring component. See below for an example table.

   a. If a state desires to provide more detailed description of changes to monitoring programs or other important information on monitoring, the state may provide this information in an additional appendix.

Required Monitoring Components	Completed? (Y/N/NA)	Additional comments
Fishery Dependent Monitoring		
Commercial Fishery		
Landings		
Harvest Composition		
Effort		
Recreational Fishery		
Landings		
Harvest Composition		

Effort		
Fishery Independent Monitoring		
Spawning stock survey		
Calculation of mortality and/or survival estimates		
Juvenile abundance survey		
Hatchery evaluation		

C. Sustainability evaluation: provide a description of any sustainability target/thresholds used in approved SFMPs, and indicate how metrics in the previous year compared to the approved targets/thresholds, and whether any management action will be taken in response.

VI. Planned management programs for the current calendar year

A. Summarize regulations that will be in effect (copy of current regulations only if different from previous year).

B. Summarize changes to monitoring programs that will be performed, only if different from previous year.

Amendment 3 requires states to annually submit all data from monitoring programs in Excel spreadsheets using the template provided at the same time as the annual report, unless determined otherwise by the Board. The PRT recommends that states continue to annually submit monitoring data in Excel only, but recommends they do not include those data in the written compliance report.

Table 6. Summary of PRT Review of 2019 State Compliance Reports.

STATE	2019 FISHERY AND MONITORING HIGHLIGHTS	UNREPORTED INFORMATION AND COMPLIANCE ISSUES
ME	In 2019, counts of river herring were close to average on the Androscoggin (81,025), Sebasticook (3,287,702) Kennebec (240,594) and the Saco (55,028) rivers while the St. Croix River (486,500) was trending upward. Based on the following sustainability guidelines and Maine laws and regulations, eighteen municipal directed river herring harvests were approved by DMR in 2019. Commercial landings of river herring were the highest recorded since 2003. Severe drought conditions in 2016 are expected to impact the 2020 river herring run. 384 confirmed juvenile American shad collected among standard and experimental seining stations in various state waterways. Multiple dams on the Mousam, Union, and Little Androscoggin Rivers are in the process of FERC relicensing. Maine DMR is working with project partners to ensure alosid fish passage is being considered a priority.	Maintained recreational shad fishery with bag limit of 2 fish per day; Shad SFMP was approved in 2020. Representative biological sampling for shad was not conducted on Androscoggin and Saco Rivers. Low run sizes discourage handling of fish. As a result, size, age, sex composition, and mortality were not calculated. Monitoring of shad recreational fishery is minimal; information presented is unlikely to reflect actual harvest. No monitoring of RH recreational catch composition. Missing biological data characterizing the spawning stock on the St. Croix and Saco Rivers. No age samples were taken on the Saco River, so mortality was not calculated. Two summons and eleven warnings were issued for either exceeding the 25-fish limit on river herring or fishing in a closed area or during a closed period.
NH	The relative abundance of juvenile alewife and blueback herring declined in 2019. Various agencies are working to remove dams for the benefit of anadromous fish on the Cocheco (Gonic dams) and Bellamy (Sawyer Mill dams) Rivers. No adult American shad and only one juvenile detected by fishery independent surveys in the Exeter River in 2019. US Fish and Wildlife Service stocked 2,829,219 marked American shad fry in the Lamprey River in 2019.	NA
MA	143,541 river herring were counted at the Essex dam fish lift on the Merrimack River in 2019. This was above the time series average of 84,350. 4,006 gravid river herring were trapped and transported into four coastal systems within Massachusetts for restoration efforts. Additionally, 26,445 alewives were trapped in Massachusetts and released into 2 Rhode Island coastal systems (2,000 fish) and 5 New Hampshire coastal systems (24,445 fish). In 2019, MA DMF staff contributed time to approximately 25 different habitat restoration projects in various stages of development and implementation. Highlights for 2019 include the completion of a new fishway at the Draka Dam on the Three Mile River, a new fish ladder at Forge Pond Dam on the Jones River, and the improvement of fish passage at the historic Herring Brook Park. 18,653 American shad were counted at the Essex Dam fish lift on the	RH: MA did not implement juvenile RH abundance survey in Merrimack or Connecticut rivers. In 2019 fourteen violations (11 civil, 3 criminal) were reported by the Massachusetts Environmental Police involving illegal catching and possession of river herring. Shad: Juvenile abundance monitoring not conducted in the Merrimack River. No report of adult mortality/survival

Table 6. Summary of PRT Review of 2019 State Compliance Reports.

STATE	2019 FISHERY AND MONITORING HIGHLIGHTS	UNREPORTED INFORMATION AND COMPLIANCE ISSUES
	Merrimack River in 2019, below the time series average of 29,037 fish. 314,361 American shad were counted at the Holyoke Dam fish lift on the Connecticut River in 2019, above the time series average of 269,755 fish. An additional 2,401 fish were transferred to trucks for transport and 67 fish were sacrificed for agency studies. MA DMF has identified the Charles and Palmer Rivers as restoration priorities for American shad. In partnership with USFWS, MA DMF participated in a feasibility study for the removal of the Watertown Dam on the Charles River.	and no juvenile abundance information reported for the Connecticut River.
RI	During the 2019 season, 35,832 river herring passed through the Gilbert Stuart fishway, 101,714 passed through the Nonquit fishway and 38,418 were estimated at Buckeye Brook. Nonquit and Buckeye Brook increased compared to 2018, while Gilbert Stuart counts fell. CPUE of river herring in the Narragansett Bay seine survey (all life stages included) increased substantially in 2019 to the highest index value on record. Only 5 juvenile shad in 50 seine hauls were collected during the juvenile abundance survey. JAI was lower than average in 2019. 115 adult shad passed through the Potter Hill fishway on the Pawcatuck River in 2019. This is about average for years from 2005 onwards. The USFWS North Attleboro hatchery that previously provided juveniles/eggs for stocking in Rhode Island could not receive shad in 2019. As a result, 242 adult shad were stocked to Rhode Island rivers from the Connecticut River in 2019.	RH: 1) Pawcatuck - missing spawning stock survey, biological sampling of the spawning stock, and mortality/survival estimates; 2) Buckeye Brook - missing the accompanying biological samples for spawning stock count. Shad: No monitoring of the recreational fishery on Pawcatuck River. Did not report on progress in implementing shad habitat recommendations.
CT	Adult blueback herring collection efforts were not conducted by CT DEEP in 2019 due to funding and staffing shortages. The CT DEEP FD Diadromous Group is continuously pursuing opportunities to expand the population with improvements to upstream and downstream fish passage at three main stem dams and some tributary dams. 2019 represented historic lows in the number of commercial shad fishers (5), fishing trips (56), and pounds of American shad landed (5,596) in the time series. None of the three fishery independent benchmarks for shad (Lift counts, escapement, and JAI) were exceeded in 2019.	The commercial shad fishery was not sampled for catch composition (except for sex) and effort estimation was not provided. This was due to the small size of the fishery, limited budget, and staffing shortages. A shad creel survey was not conducted in 2019 due to budget constraints and limited staff availability. CT staff believe age structure and length frequency collected through their fishery independent monitoring efforts are representative of those in the recreational fishery.
NY	The 2019 JAIs for both blueback and alewife were low below their established 25th quartile benchmarks. New York will closely monitor this index over the next several years, and a proactive approach will be taken if low catch rates continue. The 2019 American shad JAI marks the fifth consecutive year below recruitment failure.	A river herring recreational creel survey was not conducted in 2019 due to funding constraints. Did not report on progress in implementing habitat recommendations.

Table 6. Summary of PRT Review of 2019 State Compliance Reports.

STATE	2019 FISHERY AND MONITORING HIGHLIGHTS	UNREPORTED INFORMATION AND COMPLIANCE ISSUES
NJ	For blueback herring in the trawl survey the geometric mean ranked 6th out of 31 years and alewife ranked 29th. The geometric mean CPUE of American shad caught during the ocean trawl survey ranked 28th in the 31-year time series.	Did not include harvest and losses table, copy of regulations for commercial and rec fishery, nor summary of monitoring programs for following year. No review of progress in implementing habitat recommendations. Did not report on progress in implementing habitat recommendations.
PA	No juvenile river herring were sampled or recovered from Pennsylvania portions of the Susquehanna River in 2019. The lack of juvenile river herring from this survey is typical, as very few to no adult river herring successfully migrate upriver of Safe Harbor Dam. Passage of adult American Shad at Conowingo (4,787), Holtwood (570) and Safe Harbor (316) dams in 2019 continued a depressed passage trend observed since the early 2000s. Further, 2019 marked the lowest year of shad passage and catch recorded since the East Fish Lift at the Conowingo Dam began operations in 1991. However, fish lift operations in 2019 were partly impacted by two high flow events in later April and mid-May. Evaluation of otoliths for hatchery administered tetracycline marks from adult American Shad sampled in 2019 found 31.7% to be hatchery origin fish, which is third lowest proportion of hatchery fish identified in annual catches since 1989.	Did not include copy of commercial and recreational regulations that were in effect.
DELAWARE BASIN COOP	Commercial landings for American shad in the Delaware Estuary and Bay as reported to NJ in their directed fishery (18,299 lbs) for 2019 were well below average since 2000. Catch of adult American shad in Lewis Haul Seine survey was near record low in 2019, however, high river flows influenced gear efficacy. There is no estimation of recreational angler use and harvest for American shad in the Delaware River Basin for the 2019 season. There was a noticeable decrease in the Alewife YOY relative abundance in 2019 (0.12 geo mean) for Delaware's bottom trawl survey compared to 2018 (0.46 geo mean). Relative abundance of juvenile alewives and blueback herring in the Maurice River decreased in 2019 from 2018 levels.	Did not include copy of commercial and recreational regulations that were in effect. Otoliths and scales collected but not aged.
DE	The 2019 haul seine JAI of American shad increased from 2018. The 2019 adult electrofishing CPUE for American shad increased from 2018 and ranked sixth highest in 18-year time series. An estimated 858,000 American shad fry were stocked in the Nanticoke River tributaries during the spring of 2019. The geometric mean pf blueback herring increased from 2018 to the fifth lowest in the time series. Alewife abundance increased from 2018 to the eighth highest value in the time series.	No report on protected species interactions. Missing copy of regulations. No review of progress implementing habitat recommendations.

Table 6. Summary of PRT Review of 2019 State Compliance Reports.

STATE	2019 FISHERY AND MONITORING HIGHLIGHTS	UNREPORTED INFORMATION AND COMPLIANCE ISSUES
MD	River Herring abundance in Nanticoke River continues to be low and sizes have decreased; North East River gillnet survey sampled 1216 river herring, with relative abundance of alewife similar to 2018 and relative abundance of blueback increasing substantially. Juvenile abundance index in Upper Chesapeake Bay showed substantial increase in 2019. Estimates of abundance for adult American shad in the lower Susquehanna River in 2019 were below those observed in 2018, and remain well below time series peak values observed in the early 2000s. Relative abundance of adult American shad in the Nanticoke River (1989-2019) is highly variable year to year, and was above the time series mean in 2019. The Potomac River (1996-2019) adult American shad abundance index has significantly increased over the time series; in 2019, relative abundance increased for the third consecutive year and reached the highest value on record. The American shad juvenile abundance index (JAI) increased in the Potomac River in 2019, while the JAI in the Upper Chesapeake Bay declined. The Potomac River American shad JAI continues to be the highest index in Maryland's portion of Chesapeake Bay.	NA
DC	No juvenile shad were stocked in 2019. The fisheries research branch has been active in restoring and increasing spawning habitat in Rock Creek by removing barriers and installing a fish ladder at Pierce Mill Dam. The geometric mean for the seining survey increased for blueback herring and shad. The geometric mean for the push net survey increased for shad. The CPUE for the spawning stock survey increased for alewives and decreased for blueback herring.	No ages calculated to conduct mortality or survival estimates.
PRFC	The alewife index decreased to 0.06 in 2019 and the blueback herring index decreased to 0.61. There continues to be no directed harvest of RH in PRFC. The ASMFC American Shad restoration target of 31.1 for the Potomac River was exceeded for the 9th year in a row with a value of 49.0 in 2019. The YOY geometric mean index for American shad increased significantly from 7.36 in 2018 to 10.86 in 2019.	NA
VA	In 2019, ten weekly cruises (June to August) were conducted at night when juvenile Alosa spp. are most susceptible to surface trawling. On the Chickahominy River, a total of 184 alewives and 85 blueback herring were captured. On the Rappahannock River, a total of 220 alewives and 550 blueback herring were captured. Catches of pre-spawned alewife peaked between March 18 and April 8, with catch rates typically exceeding 0.04 fish/m/day or 0.01 kg/m/day. The American shad seine survey data on the James River showed above average recruitment in 2019. The geometric mean catch (followed by standard deviation and number of seine hauls in parentheses) of juvenile American shad captured in daylight seine hauls in 2019 was: James River, 0.13 (0.33, 65); Chickahominy River, 0.07 (0.22,	Did not include in report Protected Species interactions, summary of regulations, or monitoring efforts to be performed next year.

Table 6. Summary of PRT Review of 2019 State Compliance Reports.

STATE	2019 FISHERY AND MONITORING HIGHLIGHTS	UNREPORTED INFORMATION AND COMPLIANCE ISSUES
	10); Rappahannock River, 11.65 (1.75, 35); York River, 1.28 (1.09, 95); Mattaponi River, 2.65 (1.13, 50); and Pamunkey River, 0.40 (0.80, 40).	
NC	During 2019 sampling of the 11 core seine sites, 1,783 Blueback Herring and 4 Alewives were collected. The 2019 juvenile index of abundance was 33.02 for Blueback Herring. In 2019, a total of 3,590 (211 aged) Blueback Herring were caught in the IGNS throughout the Albemarle Sound. Landings of American Shad in 2019 were the lowest on record, since 1972 and the implementation of the reduced season. During 2019 sampling of the 14 seine sites, 1,163 American Shad were captured. The 2019 American Shad arithmetic juvenile index of abundance was 7.36 fish per seine.	Due to budgetary constraints, Recreational Commercial Gear License harvest data for shad has not been collected since 2008. Did not include summary of regulatory changes for the following year.
SC	No management actions were triggered due to any sustainability benchmark exceedances for river herring during the 2019 fishing year. For American shad, the commercial CPUE for the Pee Dee Run was 1.98; therefore, this run fell below the sustainability benchmark (3.26 fish/hr). It is believed hurricanes and resulting flooding in the area are cause for this decline. If this index stays below the sustainability benchmark one more consecutive year, management action will be taken. In 2019, the commercial CPUE for the Santee River was 1.75 kg/hr; therefore, this river fell below the sustainability benchmark (1.87 kg/hr). In 2019, the CPUE for the Edisto River was 0.13; therefore, this river fell below the benchmark. If CPUE remains below the sustainability benchmark for two more years consecutively, management action will be taken. In 2019, the CPUE for the Combahee River fell below the benchmark target; if the CPUE remains below the benchmark one more year, management action will be taken.	Did not provide estimation of repeat spawning for river herring due to low catch. Did not include summary of regulatory or monitoring changes for the following year. Did not report on progress in implementing habitat recommendations.
GA	For 2019, no commercial CPUE for shad could be derived due to zero drift-net landings for Georgia in the Savannah River. GADNR gill netting efforts on the Altamaha River in 2019 resulted in a catch rate of 2.74 American Shad/100 Net ft-hrs, which is above the sustainability benchmark. American Shad CPUE for the Ogeechee River has been trending up for the past 5-year period. 2019 sample value increased 67% from 2018 sample results and is well above the benchmark.	No regulation of river herring recreational harvest in 2019, though an alternative management plan was approved in 2020.
FL	No commercial fishery exists for shad or river herring. The JAI Survey indicated that blueback herring abundance is increasing over the time series that data were collected. American shad are at the southern extent of their range in Florida. Anglers targeting American shad saw catch rates of more than one fish per hour fishing.	For river herring, state regulations allow recreational harvest though there is no approved SFMP. For shad, state regulations allow recreational harvest statewide, though not all systems are included in the SFMP.

Table 7. Reported protected species interactions (sturgeon species) in shad or river herring fisheries in 2019. Only the states listed below reported interactions.

Jurisdiction	Atlantic sturgeon		Shortnose sturgeon		Unclassified		Total by State	
	Catch	Mortalities	Catch	Mortalities	Catch	Mortalities	Catch	Mortalities
RI							Unavailable*	Unavailable*
CT					1	0	1	0
NJ	3,893 lbs**						0	0
PRFC	2	0					2	0
VA	9	0					9	0
NC	14	0					14	0
SC	19	0					19	0
GA	37	0	57	0			94	0
Total by Species	**81**	**0**	**57**	**0**	**1**	**0**	**139**	**0**

*Rhode Island reported 87 sturgeon caught in 2018. Data for 2019 from NEFOP is unavailable.

**In 2019 gill netters in New Jersey coastal waters reported discarding 3,893 pounds of sturgeon. Number of fish and mortality is unknown.

Atlantic States Marine Fisheries Commission

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

MEMORANDUM

January 12, 2021

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

From: **Tina Berger, Director of Communications**

RE: **Advisory Panel Nominations**

Please find attached two new nominations to the Shad and River Herring Advisory Panel – Dr. Ed Hale of University of Delaware Sea Grant and Eric Roach, a recreational angler from New Hampshire. Please review these nominations for action at the next Board meeting.

If you have any questions, please feel free to contact me at (703) 842-0749 or tberger@asmfc.org.

Enc.

cc: Caitlin Starks

SHAD & RIVER HERRING ADVISORY PANEL

Bolded names await approval by the Shad & River Herring Management Board

January 12, 2021

Maine
River Herring:
Dennis L. Smith (rec. with background in alewife restoration)
P.O. Box 802
Northeast Harbor, ME 04662
Phone: (207) 288-5457
Email: rexphisn@adelphia.net
Appt. Confirmed 5/5/08
No response to March 2019 inquiry regarding continuing interest in serving on AP

Mike Thalhauser (comm)
Alewife Harvesters of Maine
13 Atlantic Avenue
Stonington, ME 04681
Phone: 207.367.2708
mthalhauser@coastalfisheries.org
Appt. Confirmed 10/30/19

Shad:
Vacancy - shad rec

New Hampshire
Shad & River Herring:
Eric Roach (rec)
54A Foggs Lane
Seabrook, NH 03874
Phone: 603.502.0928
Eroach1970@gmail.com

Massachusetts
Shad & River Herring:
Mark Amorello (rec)
P.O. Box 235
Pembroke, MA 02359
Phone: 781.831.2123
markamorello@yahoo.com
Appt. Confirmed 10/30/19

River Herring:
George "Chuckie" Green (rec/Mashpee Wampanoag Tribe)
483 Great Neck Road South
Mashpee, MA 02649
Phone (day): 508.477.0208, ext 138
Phone (eve): 774. 392.4979
Chuckie.Green@mtribe-nsn.gov
Appt. Confirmed 10/30/19

Connecticut
Shad & River Herring:
2 vacancies

New York
Shad & River Herring:
Byron Young
53 Highview Lane
Ridge, NY 11961
Phone: (631) 821-9623
Cell: (631) 294-9612
Email: youngb53@optimum.net
Appt. Confirmed 5/5/08
Chair from 1/09- 1/11

New Jersey
Shad:
Vacancy – recreational

Shad & River Herring:
Jeff Kaelin (comm. trawl and purse seine)
Lund's Fisheries, Inc.
P.O. Box 440
Winterport, ME 04496-0440
Phone: (207) 266-0440
jkaelin@lundsfish.com
Appt Confirmed 8/20/09

Pennsylvania
Vacancy

Delaware
Shad & River Herring:
1 vacancy

Dr. Edward Hale
Delaware Sea Grant
23 Gosling Drive
Lewes, DE 19958
Phone: 302.470.3380
Ehale@udel.edu

Maryland
Shad & River Herring:
Vacancy - recreational

Virginia
Shad & River Herring:
Vacancy
Shad:
Vacancy

North Carolina
River Herring:
Louis Ray Brown, Jr. (rec)
212 Walnut Creek Drive
Goldsboro, NC 27534
Phone (day): (919) 778-9404
Phone (eve): (919) 778-9792
Email: lrbrown@nc.rr.com
Appt. Confirmed 5/5/08; 8/18

Vacancy – commercial

South Carolina
Shad:
Thomas M. Rowe, Jr. (rec)
4625 Flounder Lake Drive
Meggett, SC 29449
Phone: 843-908-0247
FAX: 843-549-7575
Email: thomasmrowe@hotmail.com
Appt Confirmed 8/3/10

Vacancy – commercial net

Georgia
River Herring:
Fulton Love (dealer)
6817 Basin Road
Savannah, GA 31419
Phone: (912)925-3616
FAX: (912)925-1900
Appt. Confirmed 10/30/95
Appt. Reconfirmed 9/8/99
Appt. Reconfirmed 3/19/08
No response to Sept 2017 or March 2019 inquiry regarding continuing interest in serving on AP

Florida
Shad & River Herring:
2 vacancies

Potomac River Fisheries Commission
River Herring:
Kevin L. Gladhill (rec)
21370 Mount Lena Road
Boonsboro, MD 21713
Phone (day): (301)988-6697
Phone (eve): (301)714-1074
Email: KLGladhill@myactv.net
Appt. Confirmed 5/5/08
No response to Sept 2017 or March 2019 inquiry regarding continuing interest in serving on AP

Vacancy – commercial pound net

District of Columbia
Shad:
Joe Fletcher (rec)
1445 Pathfinder Lane
McLean, VA 22101
Phone (day): (202)244-0461
Appt. Confirmed 10/30/95
Appt. Reconfirmed 9/15/99
Appt. Reconfirmed 4/21/08
No response to Sept 2017 inquiry regarding continuing interest in serving on AP

Nontraditional Stakeholders
Chair, Pam Lyons Gromen (fisheries conservation) (1/11)
Executive Director
Wild Oceans
1793 Sandy Court
Springboro, Ohio 45066
Phone: 240.405.6931
Email: plgromen@wildoceans.org
Appt. Confirmed 5/5/08

Alison A. Bowden
Freshwater Program Director
The Nature Conservancy
205 Portland St, Suite 400
Boston, MA 02114
Phone (day): (617) 227-7017 x351

Phone (eve): (617)678-6135
FAX: (617) 227-7688
Email: abowden@tnc.org
Appt. Confirmed 5/5/08
Confirmed interest in March 2019

ATLANTIC STATES MARINE FISHERIES COMMISSION

Advisory Panel Nomination Form

This form is designed to help nominate Advisors to the Commission's Species Advisory Panels. The information on the returned form will be provided to the Commission's relevant species management board or section. Please answer the questions in the categories (All Nominees, Commercial Fisherman, Charter/Headboat Captain, Recreational Fisherman, Dealer/Processor, or Other Interested Parties) that pertain to the nominee's experience. If the nominee fits into more than one category, answer the questions for all categories that fit the situation. **Also, please fill in the sections which pertain to All Nominees (pages 1 and 2). In addition, nominee signatures are required to verify the provided information (page 4), and Commissioner signatures are requested to verify Commissioner consensus (page 4). Please print and use a black pen.**

Form submitted by: Mr. John Clark State: DE
(your name)

Name of Nominee: Edward A. Hale

Address: 23 Gosling Drive

City, State, Zip: Lewes, DE 19958

Please provide the appropriate numbers where the nominee can be reached:

Phone (day): 302.470.3380 Phone (evening): _____

FAX: _____ Email: ehale@udel.edu

FOR ALL NOMINEES:

1. Please list, in order of preference, the Advisory Panel for which you are nominating the above person.
   1. Shad & River Herring
   2. _____
   3. _____
   4. _____
2. Has the nominee been found in violation of criminal or civil federal fishery law or regulation or convicted of any felony or crime over the last three years?
   yes_____ no____X_____
3. Is the nominee a member of any fishermen's organizations or clubs?
   yes X no_____
   If "yes," please list them below by name.

Delaware Aquaculture Association

4. What kinds (species) of fish and/or shellfish has the nominee fished for during the past year?

Atlantic Croaker	Spot
Atlantic Striped Bass	Summer Flounder
Bluefish	Various other species

5. What kinds (species) of fish and/or shellfish has the nominee fished for in the past?

All of the above	Shad
Blue Mussels	Sharks
Hard Clams	Toadfish

FOR COMMERCIAL FISHERMEN:

1. How many years has the nominee been the commercial fishing business? _____ years
2. Is the nominee employed only in commercial fishing? yes_____ no_____
3. What is the predominant gear type used by the nominee?_____
4. What is the predominant geographic area fished by the nominee (i.e., inshore, offshore)?_____

FOR CHARTER/HEADBOAT CAPTAINS:

1. How long has the nominee been employed in the charter/headboat business? _____ years
2. Is the nominee employed only in the charter/headboat industry? yes _____ no_____

   If "no," please list other type(s)of business(es) and/occupation(s):_____

   _____
3. How many years has the nominee lived in the home port community? _____ years

   If less than five years, please indicate the nominee's previous home port community.

   _____

FOR RECREATIONAL FISHERMEN:

1. How long has the nominee engaged in recreational fishing? _____ years

2. Is the nominee working, or has the nominee ever worked in any area related to the fishing industry? yes X no _____

   If "yes," please explain.

_____

_____

_____

FOR SEAFOOD PROCESSORS & DEALERS:

1. How long has the nominee been employed in the business of seafood processing/dealing? _____years

2. Is the nominee employed only in the business of seafood processing/dealing?

   yes _____ no _____ If "no," please list other type(s) of business(es) and/or occupation(s):

_____

_____

_____

3. How many years has the nominee lived in the home port community? _____ years

   If less than five years, please indicate the nominee's previous home port community.

_____

FOR OTHER INTERESTED PARTIES:

1. How long has the nominee been interested in fishing and/or fisheries management? 17 years

2. Is the nominee employed in the fishing business or the field of fisheries management? yes X no _____

   If "no," please list other type(s) of business(es) and/or occupation(s):

_____

_____

_____

FOR ALL NOMINEES:

In the space provided below, please provide the Commission with any additional information which you feel would assist us in making choosing new Advisors. You may use as many pages as needed.

Nominee Signature: Edward A. Hale Jr., Ph.D. Date:

Name: Edward A. Hale
(please print)

COMMISSIONERS SIGN-OFF (not required for non-traditional stakeholders)

State Director

State Legislator

Governor's Appointee

ATLANTIC STATES MARINE FISHERIES COMMISSION

Advisory Panel Nomination Form

This form is designed to help nominate Advisors to the Commission's Species Advisory Panels. The information on the returned form will be provided to the Commission's relevant species management board or section. Please answer the questions in the categories (All Nominees, Commercial Fisherman, Charter/Headboat Captain, Recreational Fisherman, Dealer/Processor, or Other Interested Parties) that pertain to the nominee's experience. If the nominee fits into more than one category, answer the questions for all categories that fit the situation. **Also, please fill in the sections which pertain to All Nominees (pages 1 and 2). In addition, nominee signatures are required to verify the provided information (page 4), and Commissioner signatures are requested to verify Commissioner consensus (page 4). Please print and use a black pen.**

Form submitted by: Cheri Patterson (your name) State: New Hampshire

Name of Nominee: ERIC E. ROACH

Address: 54A FOGGS LANE

City, State, Zip: SEABROOK, NH 03874

Please provide the appropriate numbers where the nominee can be reached:

Phone (day): 603-502-0928 Phone (evening): 603-502-0928

FAX: N/A Email: EROACH1970@GMAIL.COM

FOR ALL NOMINEES:

1. Please list, in order of preference, the Advisory Panel for which you are nominating the above person.
   1. River Herring and Shad
   2. _____
   3. _____
   4. _____
2. Has the nominee been found in violation of criminal or civil federal fishery law or regulation or convicted of any felony or crime over the last three years?

   yes_____ no ✓
3. Is the nominee a member of any fishermen's organizations or clubs?

   yes ✓ no_____

   If "yes," please list them below by name.

PLUM ISLAND SURFCASTERS

4. What kinds (species) of fish and/or shellfish has the nominee fished for during the past year?

AMERICAN SHAD
BROOK TROUT
STRIPED BASS
SMALLMOUTH BASS
BLUEFISH

5. What kinds (species) of fish and/or shellfish has the nominee fished for in the past?

ATLANTIC SALMON
RAINBOW SMELT
LANDLOCKED SALMON
WHITE PERCH
LARGEMOUTH BASS

FOR COMMERCIAL FISHERMEN:

1. How many years has the nominee been the commercial fishing business? _____ years
2. Is the nominee employed only in commercial fishing? yes_____ no_____
3. What is the predominant gear type used by the nominee?_____
4. What is the predominant geographic area fished by the nominee (i.e., inshore, offshore)?_____

FOR CHARTER/HEADBOAT CAPTAINS:

1. How long has the nominee been employed in the charter/headboat business? _____ years
2. Is the nominee employed only in the charter/headboat industry? yes _____ no_____

   If "no," please list other type(s)of business(es) and/occupation(s):_____

3. How many years has the nominee lived in the home port community? _____ years

   If less than five years, please indicate the nominee's previous home port community.

FOR RECREATIONAL FISHERMEN:

1. How long has the nominee engaged in recreational fishing? 30 years

2. Is the nominee working, or has the nominee ever worked in any area related to the fishing industry? yes ✓ no _____

   If "yes," please explain.

CLERK AT ELDREDGE BROS. FLY SHOP, YORK, ME (2015-2016)

MANAGER OF DOMESTIC, SINGLE-MEMBER LLC: WATERSHED CUSTOM TACKLE (REGISTERED IN NH ON 1/6/21)

FOR SEAFOOD PROCESSORS & DEALERS:

1. How long has the nominee been employed in the business of seafood processing/dealing? _____years

2. Is the nominee employed only in the business of seafood processing/dealing?

   yes _____ no _____ If "no," please list other type(s) of business(es) and/or occupation(s):

   _____

   _____

   _____

3. How many years has the nominee lived in the home port community? _____ years

   If less than five years, please indicate the nominee's previous home port community.

   _____

FOR OTHER INTERESTED PARTIES:

1. How long has the nominee been interested in fishing and/or fisheries management? _____ years

2. Is the nominee employed in the fishing business or the field of fisheries management? yes _____ no _____

   If "no," please list other type(s) of business(es) and/or occupation(s):

   _____

   _____

   _____

FOR ALL NOMINEES:

In the space provided below, please provide the Commission with any additional information which you feel would assist us in making choosing new Advisors. You may use as many pages as needed.

APPLICANT HAS A MARKED, LONG-STANDING INTEREST IN AMERICAN SHAD AND RIVER HERRING AS FORAGE, BAIT, AND SPORT (SHAD).

Nominee Signature: E. E. R Date: 1/7/21

Name: ERIC E. ROACH
(please print)

COMMISSIONERS SIGN-OFF (not required for non-traditional stakeholders)

State Director

State Legislator

Governor's Appointee