Atlantic States Marine Fisheries Commission

MEETING OVERVIEW

Shad and River Herring Management Board
February 2, 2023
8:30 a.m. – 9:30 a.m.
Hybrid Meeting

Chair: Lynn Fegley (MD) Assumed Chairmanship: 2/23	Technical Committee Chair: Brian Neilan (NJ)	Law Enforcement Committee Representative: Thomas Burrell (PA)
Vice Chair: Vacant	Advisory Panel Chair: Pam Lyons Gromen	Previous Board Meeting: November 8, 2022
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 November 8, 2022

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 North Carolina American Shad Sustainable Fishery Management Plan Update (8:40-8:55 a.m.) Final Action

Background

- Amendments 2 and 3 to the Shad and River Herring FMP require all states and jurisdictions that have a commercial fishery to submit a sustainable fishing management plan (SFMP) for river herring and American shad, respectively. Plans are updated and reviewed by the Technical Committee (TC) every five years.
- North Carolina submitted an updated SFMP for TC review and Board consideration at the 2023 Winter Meeting (**Supplemental Materials**).
- The TC reviewed this SFMP update and recommendation the plan for Board approval (**Supplemental Materials**).

Presentations

- American Shad Sustainable Fishery Management Plan Update for Board Consideration by B. Neilan

Board Actions for Consideration

- Consider approval of updated SFMP for North Carolina

5. Update on 2023 River Herring Benchmark Stock Assessment (8:55-9:05 a.m.)

Background

- The river herring benchmark stock assessment was initiated in April 2022. The methods workshop is scheduled for February 2023.

Presentations

- Update on River Herring Stock Assessment Progress by K. Drew

6. Consider Fishery Management Plan Review and State Compliance for the 2021 Fishing Year (9:05-9:20 a.m.) Action

Background

- State Compliance Reports were due on July 1, 2022.
- The Plan Review Team reviewed each state report and compiled the annual FMP Review (**Supplemental Materials**).

Presentations

- Overview of the FMP Review Report by J. Boyle

Board Actions for Consideration

- Approve FMP Review for 2021 fishing year, state compliance reports, and *de minimis* requests

7. Review and Populate Advisory Panel Membership (9:20-9:25 p.m.)

Background

- There are two new nominations to the Shad and River Herring Advisory Panel from Connecticut—Stephen Gephard, a recreational angler and retired CT DEEP biologist **(Briefing Materials)**, and William Lucey, the Long Island Soundkeeper for Save the Sound **(Supplemental Materials).**

Presentations

- Nomination by T. Berger

Board Actions for Consideration

- Approve Shad and River Herring Advisory Panel Nominations

8. Elect Vice-Chair

9. Other Business/Adjourn

Shad & River Herring Technical Committee
Meeting Summary

January 19, 2023

Technical Committee Members: Brian Neilan (Chair, NJ), Wes Eakin (Vice-Chair, NY), Brad Chase (MA), Ingrid Braun (PRFC), Jeremy McCargo (NC), Ken Sprankle (USFWS), Patrick McGee (RI), Ruth Haas-Castro (NOAA), Matthew Jargowsky (MD), Patrick McGrath (VA), Jim Page (GA), Conor O'Donnell (NH), Holly White (NC), Joe Swann (DC), Johnny Moore (DE), Ted Castro-Santos (USGS)

ASMFC Staff: James Boyle and Katie Drew

The TC met via conference call on January 19, 2023 to review an update to the North Carolina Sustainable Fishery Management Plan (SFMP) for American shad and to consider a proposal from New Hampshire to reopen its river herring fishery.

The next SFMPs to be reviewed are from Connecticut (Shad) and the Potomac River Fisheries Commission (Shad).

1. **North Carolina Sustainable Fishery Management Plan (SFMP) for American shad**

Holly White presented the North Carolina SFMP for American shad, which proposed updates to some sustainability metrics and harvest seasons. Some notable changes include updating the Albemarle Sound-Roanoke River Female CPUE and relative fishing mortality (F) metrics to align with Independent Gill Net Survey methodology, and adding recreational harvest data to the relative F measurements in the Tar-Pamlico, Neuse, and Cape Fear Rivers. Additionally, a Juvenile Abundance Index was added to the Albemarle Sound-Roanoke River system sustainability metrics, which will trigger management if it exceeds the threshold for three consecutive years and is based on a fixed time series of 1996 to 2021. A full summary of the changes is included in Table 1. **The TC recommended the updated plan for approval by consensus.**

2. **New Hampshire Proposal to Reopen the River Herring Fishery**

Conor O'Donnell presented the proposal to reopen the river herring fishery, which was closed in 2021 due to low spawning run counts in 2019 and 2020. The proposal gives three reasons for the low run counts:

1) Low water temperatures during the early part of spawning season. Once water temperatures reached favorable levels river flows were significantly decreased.

2) Equipment failure and fishway modifications at the Cocheco River fishway led to loss of efficiency and decreased river herring passage. Many more river herring were observed in the

fishway but could not be accurately counted due to poor flow within the modified fishway, resulting in inaccurate electronic fish counting equipment.

3) Fish passage counts at the Pickpocket Dam fishway on the Exeter River were low despite thousands of ascending river herring observed in the vicinity of the former head-of-tide Great Dam and fishway (removed in 2016). The Pickpocket Dam is located 13.4 km upstream of the former Great Dam location. The reasoning behind such low counts is that the majority of river herring are utilizing restored spawning habitat between the former Great Dam and Pickpocket Dam and not accessing the habitat above Pickpocket Dam fishway where the electronic counting station was installed.

In response, New Hampshire changed the monitoring method on the Exeter River to use time series counts at the former Great Dam location and restored the Cocheco River fishway to a previous version, which resulted in the fishery-independent target being exceeded in 2021 and 2022.

The TC noted their recommendation to maintain fishery closures until the sustainability metrics have been met for five consecutive years. However, the TC requested that the New Hampshire SFMP be updated to include the new monitoring methods on the Exeter River with the intention of reevaluating the proposal when the TC can review the procedure in greater detail. **The TC plans to evaluate the revised proposal for Board consideration later in 2023.**

Table 1. Summary Changes to Sustainability Parameters by System from Prior NC SFMP (2018–2022) and Proposed NC SFMP(2023–2027).

System/Sustainability Parameter	Prior SFMP (2018–2022)	Proposed SFMP (2023–2027)	Trigger Management?
Albemarle Sound-Roanoke River			
IGNS Female CPUE (changed slightly additional data included)	Uses all mesh sizes, float and sink nets, female shad only Jan–May, Zone II only.	Changes: Sink nets dropped to match new IGNS methodology.	Yes, by itself if exceeds threshold 3 consecutive years. Threshold based on fixed time series 2000–2017.
Relative F (combines commercial landings and IGNS CPUE) (changed slightly additional data included)	Used only gill net landings and only IGNS meshes equivalent to commercial sector, IGNS same months as commercial harvest season (e.g. 2014–2022 IGNS used March data only).	Changes: Uses all commercial female roe landings from all gears, IGNS now all meshes females, Jan–May, Zone II, float nets only to match new IGNS methodology.	Yes, by itself if exceeds threshold 3 consecutive years. Threshold based on fixed time series 2002–2017.
Roanoke River Electrofishing (no change)	Female CPUE from WRC Roanoke River electrofishing survey.	No change.	No. Must be used in conjunction with a second index for triggering management action. Threshold based on fixed time series 2001–2017.
Juvenile Abundance Index (new metric)	Did not have one.	New since 2020 coastwide assessment.	Yes, by itself if exceeds threshold 3 consecutive years. Threshold based on fixed time series 1996–2021.
Tar-Pamlico and Neuse Rivers			
WRC Electrofishing index female only spawning grounds	Female CPUE from WRC electrofishing survey on Tar-Pamlico and Neuse rivers.	No change.	Yes, by itself if exceeds threshold 3 consecutive years. Threshold based on fixed time series 2000–2017.
Relative F (combines commercial landings and electrofishing CPUE) (changed slightly additional data included)	Female CPUE from WRC electrofishing survey on Tar-Pamlico and Neuse rivers with commercial landings.	Changes: Added recreational harvest to the commercial landings. Relative F unit represented as number of fish not pounds.	Yes, by itself if exceeds threshold 3 consecutive years. Threshold based on fixed time series 2012–2022.
Cape Fear River			

WRC Electrofishing index female only spawning grounds (changed slightly dropped sampling site from CPUE calculation)	Female CPUE from WRC electrofishing survey on Cape Fear River.	Changes: Dropped sampling site at LD-3 from analysis.	Yes, by itself if exceeds threshold 3 consecutive years. Threshold based on fixed time series 2001–2017.
Relative F (combines commercial landings and electrofishing CPUE) (changed slightly additional data included)	Female CPUE from WRC electrofishing survey on Cape Fear River with commercial landings.	Changes: Added recreational harvest to the commercial landings. Dropped sampling site from WRC electrofishing CPUE. Relative F unit represented as number of fish not pounds.	Yes, by itself if exceeds threshold 3 consecutive years. Threshold based on fixed time series 2011–2022, no value for 2012.
Harvest Season	**Prior SFMP (2018–2022)**	**Proposed SFMP (2023–2027)**	**Purpose for Change?**
Albemarle Sound-Roanoke River			
Commercial	Mar 3–Mar 24	Feb 15–Apr 14 for 2023. Could be allowed anytime Jan 1–April 14 depending on striped bass regulations and JAI, IGNS CPUE, and relative F metric. Work group still sets season annually depending on review of metrics.	Additional harvest days due to shortened season b/c of striped bass quota being met. Allows harvest from gears (pound net runaround gill net) other than float nets. Float nets still allowed ONLY Mar 3–Mar 24. Stock status Albemarle Sound is not overfishing and not depleted based on 2020 ASMFC stock assessment.
Recreational	1-fish American shad within 10-fish shad aggregate	No change in possession limit	Recreational harvest insignificant. No reliable estimate of recreational harvest.
Tar-Pamlico and Neuse Rivers			
Commercial	Feb 15–April 14	Feb 15–Apr 14 for 2023. Could be allowed anytime Feb 15–April 14 depending on CPUE, and relative F metric performance. Work group still sets season annually depending on review of metrics.	Provides language for management flexibility.

Recreational	Tar-Pam 10-fish American shad or in aggregate, Neuse 1-fish within 10-fish shad aggregate	No change	
Cape Fear River			
Commercial	Feb 20–April 11	Feb 20–Apr 11 for 2023. Could be allowed anytime Feb 20–April 11 depending on IGNS CPUE, and relative F metric performance. Work group still sets season annually depending on review of metrics.	Provides language for management flexibility.
Recreational	5-fish American shad within 10-fish aggregate	No change	
Pee Dee River			
Recreational	10-fish American shad or in aggregate	No change	Complements SC management.
All Other Internal Waters			
Commercial	Feb 15–April 14	Feb 15–Apr 14 for 2023. Could be allowed anytime Feb 15–April 14 depending on review of metrics.	Provides language for management flexibility.
Recreational	10-fish American shad or in aggregate	1-fish American shad limit within 10-fish shad aggregate	Mirrors 1-fish limit in inland waters. WRC rule implemented 2019.

North Carolina American Shad Sustainable Fishery Plan

2023

Prepared by

North Carolina Division of Marine Fisheries
3441 Arendell Street
P.O. Box 769
Morehead City, NC 28557

North Carolina Wildlife Resources Commission
1701 Mail Service Center,
Raleigh, NC 27699

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EXECUTIVE SUMMARY

In accordance with the guidelines provided in Amendment 3 to the Atlantic States Marine Fisheries Commission's Interstate Fishery Management Plan for Shad and River Herring, North Carolina submits the following American shad Sustainable Fishery Plan (SFP) for consideration by the Shad and River Herring Management Board (Board) to continue commercial and recreational fisheries in North Carolina. North Carolina's first SFP for American shad (*Alosa sapidissima*) was approved by the Board in May 2012 for 2013 through 2017. The second plan was approved in March 2018 and subsequently amended in October 2020 allowed sustainable harvest from 2018 through 2022. The purpose of the 2023 SFP is to update and modify sustainable management measures to allow for sustainable fisheries and continue the maintenance and rebuilding of American shad populations in North Carolina from 2023 through 2027. North Carolina proposes that reproduction and recruitment of American shad in all North Carolina waters be measured by indices of juvenile abundance (Albemarle Sound-Roanoke River system only), relative abundance, and relative fishing mortality (relative *F*) from the Albemarle Sound-Roanoke River, Tar-Pamlico River, Neuse River, and Cape Fear river systems.

New additions to the 2023 SFP include sustainability parameters for juvenile abundance in the Albemarle Sound-Roanoke River and female relative *F* based on the combined commercial and recreational harvest for the Tar-Pamlico, Neuse, and Cape Fear river systems. Previously, relative *F* was computed for these systems using only information from the commercial harvest of roes (females), in pounds of fish. Commercial harvest of American shad has continued to decline due to management regulations and reduced participation in the fishery in these areas. The addition of recreational data to the relative *F* calculation has shortened the time-series, but the estimates are more informative of total removals from the Tar-Pamlico, Neuse, and Cape Fear river systems. Thresholds have been established for indices in each system to define levels needed to reduce mortality and avoid diminishing potential stock reproduction and recruitment. Fisheries in each system will be determined sustainable if indices remain within their respective thresholds.

North Carolina requests recreational and commercial fisheries in all coastal rivers and will use the management measures laid out in this SFP to ensure sustainability of these fisheries. This plan is submitted jointly by the North Carolina Division of Marine Fisheries (NCDMF) and the North Carolina Wildlife Resources Commission (NCWRC) for management of American shad in North Carolina waters.

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1. INTRODUCTION

American shad (*Alosa sapidissima*) are currently managed under Amendment 3 to the Atlantic States Marine Fisheries Commission (ASMFC) Interstate Fishery Management Plan for Shad and River Herring (ASMFC 2010). Amendment 3 imposed a coastwide harvest moratorium on commercial and recreational fisheries for American shad unless states and jurisdictions develop sustainable fishery plans (SFP), which are reviewed by the ASMFC Shad and River Herring Technical Committee (TC) and approved by their Board. North Carolina's first American Shad SFP (2013 SFP) was approved by the ASMFC Shad and River Herring Management Board in May 2012 and allowed harvest from 2013 through 2017 (NCDMF and NCWRC 2012). The second plan (2018 SFP) approved in March 2018 and subsequently amended in October 2020, allowed for sustainable harvest from 2018 through 2022 (NCDMF and NCWRC 2020). The purpose of the 2023 SFP is to update and modify sustainable management measures that allow for sustainable fisheries and continue the maintenance and rebuilding of American shad populations in North Carolina from 2023 through 2027. This plan is submitted jointly by the North Carolina Division of Marine Fisheries (NCDMF) and Wildlife Resources Commission (NCWRC) for management of American shad in North Carolina waters.

The most recent stock assessment of American shad stated that adult populations in the Albemarle Sound are sustainable and not overfished, whereas a determination of stock status could not definitively be assigned for the Tar-Pamlico, Neuse, and Cape Fear rivers due to limited information (ASMFC 2020). The Neuse River total mortality rates suggested those fisheries were sustainable; however, status of the stock with respect to depleted or not depleted could not be determined. It should be noted that areas south of Albemarle Sound are in a zone where stocks transition from iteroparity (spawn multiple times over a lifetime) to semelparity (spawn only once followed by death), which can also impact the ability to determine stock status. However, for stock assessment purposes, American shad north of the Cape Fear River are iteroparous and the river systems from the Cape Fear River to Florida are considered to be semelparous.

Updates of monitoring programs supporting the 2023 SFP and performance of associated sustainability parameters will continue to be reported in annual compliance reports to the ASMFC. Annual reports are jointly submitted by the NCDMF and the NCWRC.

2. REQUEST FOR FISHERIES

North Carolina requests that the ASMFC Shad and River Herring Management Board consider this request to approve a SFP for American shad in the state of North Carolina. This plan includes a request for approval of both recreational and commercial harvest within the state waters. North Carolina justifies this request based on analysis of historical trends in fishery-independent and fishery-dependent data for the Albemarle Sound-Roanoke River, Tar-Pamlico River, Neuse River, and Cape Fear River systems.

3. DEFINITION OF SUSTAINABILITY

A sustainable fishery is defined in Amendment 3 as one that demonstrates shad stocks could support commercial and/or recreational harvest that will not diminish future stock reproduction and recruitment. North Carolina proposes that reproduction and recruitment of American shad in all North Carolina waters be measured by indices of relative abundance and relative fishing mortality (relative *F*) from the Albemarle Sound-Roanoke River, Tar-Pamlico River, Neuse River, and Cape Fear River systems. Additionally, American shad in the Albemarle Sound-Roanoke River should be measured by an index of juvenile abundance. Thresholds have been established for indices in

each system to define levels needed to reduce mortality and avoid diminishing potential stock reproduction and recruitment. Fisheries for each system will be determined sustainable if indices remain within their respective thresholds. Exceedance of a threshold or a suite of thresholds for three consecutive years will necessitate system specific management action.

The 2023 SFP has built upon the improvements of the 2018 SFP for relative *F* by incorporating recreational and commercial harvest data (numbers of fish) into the calculation of sustainability parameters for the Tar-Pamlico, Neuse, and Cape Fear river systems. Previously, relative *F* was computed for these systems using only information from the commercial harvest of roes (females), in pounds of fish. Commercial harvest of American shad has continued to decline due to increased gear restrictions and reduced participation in the fishery in these areas. Harvest from the recreational sector has nearly equaled or exceeded commercial harvest in recent years, except for the Albemarle Sound-Roanoke River where recreational harvest is unknown but is assumed low compared to commercial landings. The addition of recreational data to the relative *F* calculation has shortened the time-series for these systems, but the estimates are more informative of total removals for the Tar-Pamlico, Neuse, and Cape Fear river systems as commercial harvest continues to decline due to gear restrictions (described in Section 4.2) and reduced participation in the commercial fishery.

Newly proposed for the 2023 SFP, is an Albemarle Sound sustainability parameter monitoring juvenile abundance. During the 2018 SFP an Albemarle Sound index of juvenile abundance for American shad was developed through the 2020 Benchmark Stock Assessment for American shad (ASMFC 2020). Using the same subset of stations and time-series from the assessment, a sustainability parameter for juvenile relative abundance, expressed as a catch-per-unit-effort (CPUE), has been added to the 2023 SFP for the Albemarle Sound.

The updated sustainability parameters are described below for each system and summarized in Table 1. The selected sustainability parameters will be reported in annual compliance reports and any management actions will be noted. Potential management actions are included in Section 14 to eliminate repetition within each of the river system sections, although any action or suite of actions could be specific to and independent of each system.

3.1 Previous Sustainable Fishery Plans

In the 2013 SFP, a suite of potential sustainability parameters was considered, and it was decided to develop individual sustainability parameters for the Albemarle Sound-Roanoke River, Tar-Pamlico River, Neuse River, and Cape Fear River systems based on female relative abundance and female relative fishing mortality rate (relative *F*). Relative abundance was calculated using available fisheries-independent survey data that were considered appropriate for measuring the abundance of American shad and were expressed in terms of CPUE. Relative *F* is calculated by dividing landings, in this case female (roe) landings, by a fisheries-independent index of relative abundance (Sinclair 1998). Relative *F* was computed by using a centered 3-year average, resulting in the first and last year of the time series based only on two years of data. A 3-year average was chosen to dampen the noise of the survey index in place of point estimates in the denominator. Sustainability parameter thresholds (75th and 25th percentiles) were not fixed and changed with the addition of new data.

The 2018 SFP used the same female sustainability parameters of relative *F* and abundance indices as the 2013 SFP, except relative *F* was computed by dividing commercial landings by a hind cast 3-year average of a survey index whereas the previous plan used a centered 3-year average. The hind cast 3-year average ensures the value of the final year in the time series (which can trigger

management action) remains unchanged once calculated. Indices of relative abundance and estimates of relative *F* were calculated for each system through 2017. Thresholds (75th and 25th percentiles) for sustainability parameters were fixed using available survey data from 2000 or 2001 (system specific survey time-periods) through 2017 and remained fixed through the 5-year management period.

4. FISHERY MANAGEMENT PROGRAM

American shad are jointly managed by the North Carolina Marine Fisheries Commission (NCMFC) and the NCWRC. The NCDMF implements NCMFC rules for American shad in the Atlantic Ocean as well as the Coastal Fishing Waters of North Carolina, while the NCWRC Inland Fisheries Division manages American shad in Inland Fishing Waters. Both commissions share management authority for recreational fishing for American shad in Joint Fishing Waters of the state, while the NCMFC has authority over commercial fishing for American shad in Joint Fishing Waters. The known extent of American shad in North Carolina river systems is shown in Figure 1. This plan is developed by the American Shad Working Group (ASWG) which consists of biologists from both NCDMF and NCWRC. The ASWG meets annually to review sustainability parameters and develop associated actions for the management of American shad in North Carolina's Inland, Joint, and Coastal Fishing Waters.

4.1 Commercial Seasonal Restrictions (statewide)

From the 1950s to 1965, a January 1 through May 1 commercial season existed in Coastal Fishing Waters, while a January 1 through June 1 season existed in Inland Fishing Waters throughout the state. From 1966 through 1994, no seasonal restrictions existed for the commercial fishery. Since 1995, a commercial season of January 1 through April 14 has been in place in Coastal and Joint Fishing Waters although the fishery is rarely opened prior to February 1 each year. Implementation of this seasonal restriction reduced harvest, as a large portion of the commercial American shad harvest historically occurred after April 14 and into May. The ocean intercept fishery for American Shad was closed to all harvest January 1, 2005 (ASMFC 2002). On July 1, 1996, NCWRC designated American shad as a game fish in Inland Fishing Waters; the game fish designation prohibited sale of American shad thereby ending any commercial harvest in Inland Fishing Waters of the state.

In 2013, under the first year of the North Carolina American shad SFP, the commercial seasons were restricted to February 15 through April 14 in all systems except for the Cape Fear River (Table 1). In the Cape Fear River, the commercial season was restricted to February 20 through April 11. Following the 2013 season, thresholds in the Albemarle Sound-Roanoke River system were exceeded for three consecutive years (2011, 2012, and 2013) triggering further management action; as a result, the commercial season was reduced to March 3 through March 24 to constrain harvest. This reduced season has remained in place for the Albemarle Sound-Roanoke River system since 2014.

4.2 Commercial Gear Restrictions

4.2.1 Albemarle Sound-Roanoke River

In the Roanoke River the use of anchored gill nets has been closed since 1991 and drift gill nets have been prohibited since 1993. These measures greatly reduced the harvest of American shad.

Since 1987, western Albemarle Sound (also referred to as Batchelor Bay) has been closed to the use of gill nets from February through mid-November. While the purpose of the closure was for striped bass (*Morone saxatilis*) conservation, it also provided additional protection for American

shad. From 1988 through 1990, yardage limits of 1,000 to 2,000 yards were implemented for large mesh (≥5.25-inch stretch mesh) gill nets in Albemarle Sound, and nets could only be set five days per week. In April 2016, the NCMFC adopted a permanent rule implementing yardage restriction for nets with a mesh length of 4.0-inch stretched mesh or greater, the maximum length of gill net shall not exceed 2,000 yards per vessel in all Internal Coastal Fishing Waters regardless of the number or individuals involved. In 2019, the NCMFC reduced the maximum amount of large mesh gill net allowed to 1,500 yards through adoption of Amendment 2 of the N. C. Southern Fishery Management Plan (FMP; NCDMF 2019a).

From 1998 through 2020, commercial gear restrictions in Albemarle Sound have been consistent and include a prohibition on the use of anchored gill nets with a mesh size of 3.5–5.0 inches stretched mesh and a limit of 1,000 yards on the use of 5.25-inch and greater (floating) stretched mesh during the open shad season. When the shad season closed, these floating shad nets are removed from the water.

During the 2021 open shad season (March 3–March 24), anchored, floating gill nets 5.25-inch and greater remained limited to 1,000 yards. However, these nets were removed from the water prior to the close of the shad season on March 18, 2021. The closing date for this gear occurred when the Albemarle Sound Management Area (ASMA) striped bass harvest quota was met to prevent additional striped bass discards.

During the 2022 open shad season (March 3–March 24), anchored, floating gill nets 5.25-inch and greater were allowed only in portions of the Albemarle Sound and limited to 700 yards per commercial operation. Area closures and yardage limits were aimed at reducing striped bass discards but also greatly reduced American shad landings from these gears. These nets were subsequently removed on March 15, 2022, when the ASMA striped bass harvest quota was met to prevent additional striped bass discards.

While there are restrictions on how gear can be used, there are no restrictions on what gear can legally be used to harvest American shad during the open season. Anchored, floating gill nets are the primary gear type used to harvest shad commercially in the Albemarle Sound. From 2013 to 2022, 95.6% of American shad harvested in the Albemarle Sound were from anchored, floating gill nets. Other commercial gear types contributing to shad harvest, include run around gill nets, drift gill nets, and pound nets. These other gear types are harvesting American shad as bycatch while pursuing other fisheries like catfish (run around, drift) and bait (pound net).

4.2.2 Tar-Pamlico and Neuse Rivers

Since 2016, a statewide rule limits the amount of large mesh (4.0-inch and greater) gill net set in internal Coastal Fishing Waters to no more than 2,000 yards per vessel. Prior to 2016, a former rule was suspended in most internal Coastal Fishing Waters as a result of sea turtle conservation measures to institute no more than 2,000 yards per vessel of 4.0–6.5-inch gill net in the Tar-Pamlico and Neuse systems. In 2019, the maximum amount of large mesh gill net allowed was reduced to 1,500 yards under Amendment 2 of the N. C. Southern FMP (NCDMF 2019a). Additionally, in certain sections of the Tar-Pamlico and Neuse rivers, gill nets with a mesh size less than 5.0-inch must be attended at all times.

Also, it is unlawful to use gill nets of any mesh size in designated Joint Fishing Waters from midnight on Friday to midnight on Sunday each week (except for portions of Albemarle and Currituck sounds). These existing gill net measures have likely reduced American shad harvest

since they have remained in effect since the spring 2012 fishing season and will remain in effect indefinitely.

Effective March 18, 2019, 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 was prohibited. This gill net prohibition, directed by the NCMFC in response to Supplement A to Amendment 1 to the N. C. Estuarine Striped Bass FMP, was intended to reduce striped bass fishing mortality but also greatly reduced American shad landings in these systems by removing gill nets from the primary fishing grounds for American shad in the Tar-Pamlico and Neuse rivers (NCDMF 2019b).

Any legal commercial gear type can be used to harvest American shad during the open season. Anchored, floating gill nets are the primary gear type used to harvest shad commercially in the Tar-Pamlico and Neuse rivers. From 2013 to 2022, 99.4% and 97.6% of American shad harvested in the Tar-Pamlico and Neuse rivers were from anchored, floating gill nets, respectively. Other commercial gear types contributing to shad harvest include run around gill nets, drift gill nets, and fyke nets. In 2018, hook-and-line gear was used to harvest 76 pounds of American shad from the Neuse River.

4.2.3 Cape Fear River

Gill net restrictions in the Cape Fear system are different than those described above for the Tar-Pamlico and Neuse river systems. Large mesh anchored gill nets, when allowed, are limited to lengths no greater than 100 yards with at least a 25-yard space between each individual length of net. Only single overnight sets are allowed; and nets can only be set one hour prior to sunset and must be retrieved within one hour of sunrise. Set gill nets are not allowed on Friday or Saturday evenings, and the maximum yardage allowed was reduced from 1,000-yards per vessel to 750-yards in May 2019 (NCDMF 2019a). It is unlawful to use gill nets of any mesh size on weekends in the Cape Fear River system.

Effective February 15, 2017, anchored large mesh gill nets (4.0–6.5-inch) are prohibited in the Cape Fear River (north of the Railroad Bridge) and Northeast Cape Fear River (north of I-40 bridge) north of Wilmington, NC. Run-around, strike, drop, trammel, and drift gill nets between 4.0–6.5 inches are allowed in these areas of the Cape Fear River and Northeast Cape Fear River, but they must be set and immediately retrieved or be actively fished from deployment through retrieval as the net is moved along by water current. Run-around, strike, drop, and trammel gill net commercial operations are limited to 800 yards per commercial fishing operation while drift gill nets are limited to 2,000 yards. Starting in 2020, drift gill nets were limited to 1,500 yards per commercial fishing operation in accordance with Amendment 2 to the N. C. Southern Flounder FMP (NCDMF 2019a). These gill net gears are also exempt from gill net construction and setting time requirements required for anchored large mesh gill nets. Since 2020, with the implementation of Amendment 2 to the N. C. Southern Flounder FMP, anchored large mesh gill nets have not been allowed during the commercial shad season in the Cape Fear River. Following the removal of anchored large mesh gill nets above the Railroad Bridge in 2017, drift gill nets are the primary gear used for commercial harvest of American shad in the Cape Fear River.

Any legal commercial gear type can be used to harvest American shad during the open season. Drift gill nets are the primary gear type used to harvest American shad commercially in the Cape Fear River. From 2013 to 2022, 99.4% of American shad harvest in the Cape Fear River were from drift gill nets. Other commercial gear types contributing to shad harvest include run around gill nets and hook-and-line.

4.2.4 All Other Internal Joint and Coastal Fishing Waters

There are no restrictions on the commercial gear type used to harvest American shad during the open season. Anchored gill nets (large and small mesh) are the primary gear type used to harvest American shad commercially in all other Coastal Fishing Waters. From 2013 to 2022, 97% of American shad harvested from other areas were from anchored gill nets. Large mesh gill nets (>=5-inch stretched mesh) account for 47% of the harvest, while small mesh gill nets (< 5-inch stretched mesh) account for 50%. Other commercial gear types contributing to shad harvest include run around gill nets, drift gill nets, fyke nets and pound nets.

4.3 Recreational Restrictions

Prior to 1995, no recreational harvest restrictions existed for American shad and hickory shad (*Alosa mediocris*). Beginning in 1995, it became unlawful to take American shad and hickory shad by any method except hook-and-line from April 15–December 31 in Coastal Fishing Waters. Additionally, from 1995 through 1998, there was a recreational season during January 1 through April 14. Beginning in 1999, statewide rules implemented by NCDMF and NCWRC made it unlawful to possess more than 10 American shad and hickory shad in the aggregate in all Coastal and Inland Fishing Waters. On August 1, 2019, NCWRC amended the statewide rule for harvesting shad in Inland Fishing Waters to include no more than one American shad in the 10-shad aggregate except for Inland Fishing Waters of the Tar-Pamlico (5-American shad), Pee Dee (10-American shad), and Cape Fear river systems (10-American shad). Effective August 23, 2022, NCMFC readopted a rule with amendments that removed the fixed season and creel limit requirements for American shad in Coastal Fishing Waters, while retaining in rule the requirement making it unlawful to take or possess American shad from the Atlantic Ocean. Prior to this modification, changes to the season and creel limit for American shad could only occur if portions of the existing rule were suspended and a new season or creel limit was implemented via the NCDMF Director's proclamation authority. Removing the fixed season and creel limit from rule allows for management in accordance with the SFP to be implemented statewide in Coastal Fishing Waters using the NCDMF Director's proclamation authority without first having to suspend portions of this rule, reducing confusion.

In addition to Coastal Fishing Waters managed by the NCMFC and Inland Fishing Waters managed by NCWRC, Joint Fishing Waters are those areas where NCMFC and NCWRC have overlapping management authority. For these areas the NCMFC and the NCWRC adopted joint rules to effectively manage fisheries resources. Both the NCMFC and NCWRC have adopted rules that make it unlawful to possess more than 10 American shad and hickory shad in the aggregate. The NCWRC readopted this rule April 14, 2022. The NCMFC readopted this rule June 23, 2022, and it is pending review by the N. C. General Assembly in 2023 for an unrelated requirement. The current version of the NCMFC rule that is in force is substantively identical to the pending version. A portion of the current NCMFC rule is suspended by the NCDMF Director, and a proclamation is issued to set the shad creel limits in Joint Fishing Waters consistent with the SFP. The NCWRC does not have proclamation authority, so there is currently an inconsistency in the regulations for Joint Fishing Waters between these two management authorities.

The recreational changes noted here have been implemented via rule in Inland Fishing Waters by the NCWRC and via proclamation and rule in Coastal and Joint Fishing Waters by NCDMF and NCMFC.

4.3.1 Albemarle Sound-Roanoke River

In 2008, the NCWRC implemented a 1-fish American shad limit within the 10-fish shad aggregate creel limit for American and hickory shad in the Inland Fishing Waters of the Roanoke River basin. In 2013, under the first year of the North Carolina American shad SFP, a 1-fish American shad limit within the 10-fish shad aggregate creel limit was implemented by NCDMF in the Joint and Coastal Fishing Waters of the Albemarle Sound drainage including Currituck Sound, Roanoke River and all tributaries thereof. All Inland Fishing Waters of the Albemarle Sound drainage except the Roanoke River remained under the statewide rule of 10 American shad and hickory shad in the aggregate until the statewide rule for Inland Fishing Waters was changed by NCWRC to one American shad per day on August 1, 2019.

Due to the size of the Albemarle Sound, there is no recreational effort for American shad in the sound itself, and little to no effort is concentrated in the tributaries of the Albemarle Sound. Most recreational effort occurs in the Roanoke River where the focus of angler effort is on striped bass and hickory shad; American shad catch is primarily incidental. In Virginia, the Meherrin, Nottaway, and Blackwater Rivers drain into the Chowan River, the system where a substantial portion of the spawning stock entering the Albemarle Sound ascend to spawn. Recreational effort in these Virginia systems is not taken into consideration under this plan. While the impact of recreational harvest in Virginia waters is unknown, the creel limit in Virginia portions of these rivers was a 10-fish aggregate for American and hickory shad until Virginia established a statewide moratorium for American shad harvest on January 1, 2019.

4.3.2 Tar-Pamlico River

No more than 10 American and hickory shad in the aggregate may be possessed throughout the waters of the Tar-Pamlico River and its tributaries.

4.3.3 Neuse River

A NCWRC rule implementing a 1-fish limit for American shad within the 10-fish shad aggregate creel limit for American and hickory shad in the Inland Fishing Waters of the Neuse River became effective in August 2012. NCDMF complemented the 1-fish limit in Joint and Coastal Fishing Waters in 2013 under the first iteration of the North Carolina American Shad SFP. American shad harvest in Inland Fishing Waters of the Neuse River basin was incorporated into the statewide rule for Inland Fishing Waters on July 1, 2019.

4.3.4 Cape Fear River

In November 2013, the NCWRC implemented a 5-fish limit for American shad within the 10-fish shad aggregate creel limit in the Inland Fishing Waters of the Cape Fear River basin. NCDMF complemented the 5-fish limit in Coastal and Joint Fishing Waters in 2013.

4.3.5 Pee Dee River

No more than 10 American and hickory shad in the aggregate may be possessed throughout the waters of the Pee Dee River and its tributaries, which are all Inland Fishing Waters.

4.3.6 Atlantic Ocean

Possession of American shad is prohibited.

4.3.7 All Other Internal Waters

Recreational catch or harvest of American shad is very rare in internal waters other than those internal waters described above. However, a daily recreational harvest limit of up to 1-fish limit of

American shad within the 10-fish shad aggregate is allowed in all internal waters not specified above.

5. STOCK MONITORING PROGRAMS

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

5.1 Fishery-Independent Monitoring

5.1.1 Juvenile Seine Survey

The NCDMF does not have a dedicated juvenile (age-0) survey for American shad, but conducts two juvenile beach seine surveys in the Albemarle Sound area using an 18.5 m (60 ft) bag seine (Figure 2). Although the surveys were designed to monitor river herring [blueback herring (*Alosa aestivalis*) and Alewife (*Alosa peseudoharengus*)] and striped bass, both surveys capture American shad. The river herring beach seine survey has been conducted in the Chowan River and Albemarle Sound area to monitor blueback herring and Alewife abundance since 1972. The survey established 11 stations in the near-shore nursery areas of the Chowan River and Albemarle Sound, sampled twice a month. The striped bass beach seine survey has been conducted in the western Albemarle Sound to monitor juvenile striped bass since 1993. This survey was designed to determine the critical point (egg, larval, or early juvenile stage) that was limiting spawning success resulting in near zero catches in the juvenile trawl surveys for striped bass. The survey established nine stations in the near-shore nursery areas of the western Albemarle Sound, where early-stage juvenile striped bass would be settling after larval metamorphosis from spawning grounds on the Roanoke River. The stations are sampled once a week, for six weeks (starting the first week in June). Following the six weeks of sampling, the stations are sampled bimonthly through October. American shad captured are recorded but not consistently until 1995.

During the ASMFC 2020 benchmark stock assessment for American shad (ASMFC 2020) a combination of seine stations from the river herring survey (five stations) and the striped bass survey (nine stations), including all sampling events, were selected to determine a juvenile abundance starting in 1996 (zero catches in 1995). A Zero-inflated Negative Binomial (ZINB) generalized linear model (GLM) model was determined as the best recommended predictor of relative annual abundance. Water temperature, salinity, month, and cloud cover were all shown to significantly impact catch rates and presence. The best performing model was Counts ~ Year + water temperature + salinity | salinity + cloud cover + month. Updates to annual trends in abundance are included in this SFP expressed as arithmetic mean, in lieu of updating the ZINB model annually. Juvenile Abundance Indices (JAI) for American shad were calculated for the 14 stations sampled from 1996 through 2022. The JAI value for 2022 is preliminary and subject to change. One unit of effort is equal to one haul of the seine or sampling event. Samples were sorted by species and 30 randomly selected individuals of each target species present were measured. Other species present were also noted. Water temperature, salinity, and other environmental characteristics were measured and recorded.

No juvenile abundance indices exist for the Tar-Pamlico, Neuse and Cape Fear river systems at this time.

5.1.2 Adult Stock Monitoring

5.1.2.1 Spawning Area Survey (electrofishing)

An annual spawning stock survey and representative sampling for biological data is required from the Albemarle Sound and its tributaries, Tar-Pamlico, Neuse, and Cape Fear river systems for American shad. Sampling in these areas was initiated by the NCWRC in 2000. Restrictions due to the Covid-19 pandemic prevented most sampling programs during 2020.

NCWRC personnel collect American shad from the Roanoke, Tar-Pamlico, Neuse and Cape Fear river systems annually during February–June. A boat-mounted electrofishing unit (pulsed DC; 60–120 Hz; 3,000–8,000 peak watts) is used (1 or 2 dip netters) to capture fish during daylight hours, and electrofishing times are recorded in seconds. To minimize size selection during sampling in all river systems, shad are netted as they are encountered regardless of size. Relative abundance of each year-class is indexed by CPUE expressed as the number of fish captured per hour of electrofishing. However, CPUE is converted to fish per minute for sustainability indices described below. American shad broodstock collections are usually excluded from calculations of CPUE unless collections occur during regular sampling activities. Total length (mm), weight (g), and sex are recorded for all captured fish. Sampling protocols are unique to each river system and have been refined throughout the survey period. River-specific descriptions of spawning area surveys are provided in the following sections.

5.1.2.1.1 Roanoke River

American shad surveys have been conducted in the Roanoke River from 2001 through 2022. The surveys occur in the mainstem Roanoke River near the Gaston Boating Access Area at river kilometer (rkm) 225. The survey area encompasses the most upstream American shad spawning habitat in the Roanoke River, and further migration beyond the survey area is blocked by Roanoke Rapids Dam at rkm 227. During 2000–2007, sampling was concurrent with striped bass surveys in the same sample area and was restricted to April and May. Beginning in 2008, sampling was started earlier in March when water temperatures approach 10^{o}C and continued weekly until low-flow conditions restrict boat navigation or until spawning appears complete (typically end of May or first of June). One dip netter was used 2000–2004 and 2010–2011, whereas two dip netters were used 2005–2009 and 2012–2022. Also, in earlier years (2000–2012), two or three shoreline sample sites approximately 1-km each were sampled per week. In 2013–2022, however, samples were conducted at nine sampling sites once per week during the survey period. Electrofishing commenced at the upstream portion of each 500-m site and continued downstream the entire transect. Sites were randomly selected from shoreline and mid-channel habitats along the 3-km stretch downstream of the Hwy 48 bridge. Total electrofishing effort increased from previous years, but the new sample protocol still occurs in the same area as previous years.

5.1.2.1.2 Tar-Pamlico River

American shad spawning area surveys have been conducted on the mainstem Tar-Pamlico River from 2000 through 2022. Survey protocols have changed relatively little throughout the survey period. One dip netter is used to capture fish during daylight hours. Electrofishing samples are typically conducted weekly during March–May. Sampling begins when water temperatures approach 10^{o}C. Sample sites are located within one of three approximately 15-km segments that encompass most of the American shad spawning habitat in the Tar-Pamlico River. Segment 1 contains the river stretch from Rocky Mount Mill Dam downstream to the Dunbar Boating Access Area (BAA). Segment 2 includes the river stretch from Dunbar BAA downstream to the Bell's Bridge BAA. Segment 3 continues from the Bell's Bridge BAA downstream to the Tarboro town

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

5.1.2.1.3 Neuse River

American shad electrofishing surveys have been conducted in the Neuse River from 2000 through 2022, and one dip netter is used to capture fish during daylight hours. Electrofishing samples are conducted weekly during March–May. Sampling begins when water temperatures approach 10ºC and ends when spawning appears to be complete. Sampling is conducted near known spawning areas at Goldsboro, NC (rkm 240) and Raleigh, NC (rkm 350). Sampling begins at the downstream Goldsboro location in March, and the Raleigh location is added to the weekly sampling regime once 30–40 American shad are collected in one day at the Goldsboro location. Weekly sampling locations are contingent upon water levels because low flows limit navigability. The Raleigh location is only accessible at moderate to high flows and is dropped from weekly sampling when flows are not adequate for safe and effective sampling. When conditions improve, sampling is resumed at the Raleigh location. Sampling locations have been consistent throughout the survey period, but sampling protocols at each location have varied over time. In early years of the survey, two sample sites were sampled at each location. The sample sites were 2–3 km long and took over one hour of electrofishing time to complete. Since 2015, two or three sample sites are sampled at each location, but the sites have been shortened to around 1-km and electrofishing effort has been reduced. Nevertheless, the same areas have been consistently sampled throughout the survey.

5.1.2.1.4 Cape Fear River

Sampling for American shad has occurred in the Cape Fear River from 2001 through 2022. Sampling occurs at the base of Lock and Dams 1, 2, and 3. In most years, one dip netter was used to collect American shad, but two dip netters were used 2015–2017 to avoid gear saturation caused by increases in American shad abundance. In all survey years, sampling occurred at three fixed sample sites adjacent to the base of each of three locks and dams found on the river. Since 2010, sampling efforts have been standardized by electrofishing for 30 minutes downstream of each lock and dam–15 minutes from the middle of each dam down each shoreline. Sampling at each site is attempted weekly during March–May when water temperatures approach 10ºC and is ended when spawning appears complete or when high fish densities cause high catch rates and increased sampling-induced mortality. Prior to 2010, however, sampling was more sporadic and did not always occur at each site every week. Other areas in the Cape Fear River upstream of the locks and dams (Buckhorn Dam and Smiley's Falls) are occasionally sampled, but data from sites other than the locks and dams are not included in annual relative abundance analyses. Sampling at the locks and dams is possible under most flow conditions, but flood events can periodically prevent sampling.

5.1.2.2 Albemarle Sound Independent Gill Net Survey (IGNS)

Since 1990, NCDMF has been conducting an independent gill net survey throughout the Albemarle Sound area. The survey was designed for striped bass data collection and occurs November through May each year. However, American shad are captured during the survey and size, age and sex data are collected. Forty-yard segments of gill net from 2.5- through 7.0-inch stretched mesh, in half-inch increments, as well as 8.0, and 10.0-inch stretched mesh are utilized. The sound is divided into zones and random grids are selected within these zones (Figure 3). Within each grid lines of float and sink nets are set in both shallow and deep strata if they are present in the grid. Areas fished, sampling effort and sampling frequency vary seasonally. Each unit of effort is one 40-yard net, fished for 24-hours. Gill nets are fished in 40-yard shots totaling 960 yards per set (24 units of effort). The survey as described above was suspended February 2020 due to protected species interactions and resumed, under a modified sampling design in November 2021.

In November 2021, the Albemarle Sound Independent Gill Net Survey (IGNS) expanded from six to eight zones and reduced soak time from 24-hours to 12-hours. Additionally, in March 2022, sink gill nets were removed from the survey, reducing effort to 480 yards per set (12 units of effort). Additional zones were added to meet NCDMF research priorities to expand the spatial coverage of the survey. Soak times were reduced and sink nets were removed to reduce interactions with endangered species through ongoing consultation with the United States Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Association (NOAA Fisheries). It should be noted that with such a major change in survey design, the index derived from this survey starting in November 2021 will not be directly comparable to the prior historical time series. When calculating sustainability parameters using historical IGNS data, all sink gill nets were removed. It is important to note that most American shad intercepted in the IGNS survey are from float gill nets. Therefore, the removal of sink gill nets from the data set did not significantly impact the relative abundance estimates of American shad from the survey. It is not possible to determine how reducing from 24-hour to 12-hour soak times will impact comparison of American shad catches across the time series.

5.1.2.3 Pamlico Sound and Rivers Independent Gill Net Survey (IGNS)

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

American shad intercepts from the Pamlico Sound and River IGNS are low due to survey location. Indices of abundance for American shad using this survey could not be developed. Therefore, these data have not been incorporated into sustainability parameters.

5.1.2.4 Albemarle Sound American Shad Mixed-Stock Analysis

The Roanoke River and Chowan River tributaries are known spawning rivers for American shad entering Albemarle Sound. Despite the restoration efforts and research that has occurred in the Roanoke River, the proportion of American shad migrating up either the Chowan River or Roanoke River remains uncertain although a recent study suggests most are ascending up the Chowan to spawn. The NMFS and NCDMF partnered together to conduct an acoustic telemetry study to

determine migratory patterns of Albemarle Sound American shad. The objective of this study was to determine which river basins are used by adult American shad during the spawning run in 2013, 2014, 2016, 2017, 2018, and 2019. During the study acoustic receiver coverage was available through receivers maintained and operated by NCDMF, NCWRC, and Dominion Energy to track movement of Atlantic sturgeon, striped bass, and American eel. The study area encompassed the Albemarle Sound, and its associated sounds (Croatan and Currituck) and rivers: North, Pasquotank, Little, Perquimans, Chowan, Roanoke, Scuppernong, and Alligator in northeastern North Carolina and the Meherrin, Nottaway, and Blackwater in southeastern Virginia. Adult American shad were captured in gill nets with mesh sizes ranging from 4.5–6.0 inches at locations north and south of the western side of North Carolina Highway 32 bridge. This area is a funneling point for American shad that have entered the Albemarle sound to reach spawning grounds on either the Chowan River (north) or the Roanoke River (south). American shad were implanted with VEMCO V9-2x-A69-1601 coded acoustic transmitter and a PIT tag (only in 2013). Tagged fish were measured and assigned sex if possible. Fish were tagged by inserting the tag through the esophagus into the stomach. Fin clips were taken in 2016 through 2019 to determine hatchery contribution from Roanoke River stocked fish. The acoustic transmitter released a frequency every 90 seconds and tag life was expected to be around two years.

A total of 266 American shad have been tagged from 2013 through 2019. Table 10 shows the numbers of fish tagged, detected, and those that made spawning runs up the Roanoke or Chowan Rivers. The fish that were detected but did not make spawning runs, either demonstrated strong fall-back behavior and presumably left the sound or are thought to have died. Of the 62 fish that made detectable migrations during the six study years, 55 fish (89%) ascended the Chowan River, while only five ascended the Roanoke River and two entered other rivers. Shad movement data gathered by this study suggest that a large portion of the spawning stock entering the Albemarle Sound ascend the Chowan River to spawn. In 2021, results of the "Use of Acoustic Telemetry to Identify Spawning River and Spawning Migration Patterns of American Shad in the Albemarle Sound, North Carolina" were published in the North American Journal of Fisheries Management (Mack et al. 2021).

Staff with NCWRC evaluated population level genetics to determine potential genetic differences between Chowan River and Roanoke River spawning stocks. In 2019, American shad fin clips collected from Chowan River tributaries (Nottaway River and Blackwater River in Virginia) and from spawning grounds in the Roanoke River were analyzed using Program STRUCTURE. The analysis found no difference between the baseline population structure of the rivers sampled, and one genetic population was also supported by low F_{st} values (Evans and McCargo 2021). Using the suite of microsatellite markers available, it appears the populations of American Shad in the Chowan and Roanoke rivers are genetically similar. However, further evaluation using other microsatellite markers or SNPs is necessary to definitively conclude the status of genetic differences in the Albemarle Sound region.

5.2 Size, Age and Sex Determination

5.2.1 Spawning Area Survey (electrofishing)

Sex is determined for each captured fish by applying directional pressure to the abdomen toward the vent and observing the presence of milt or eggs. Each fish is measured for total length in millimeters. Scales are removed from the left side of each fish between the lateral line and the dorsal fin. To determine age, scales are examined at 33X magnification on a microfiche reader and annuli are counted. Spawning marks are recorded separately. Scales were used for ageing in all

spawning area surveys from 2000 through 2010, but beginning in 2011, NCWRC staff switched to otoliths for assessing age of American shad collected during spawning area surveys. A subsample of fish (up to 10 per 10-mm size group) was used for ageing in most systems, and otoliths from broodstock were aged when available because broodstock are sacrificed when hatchery spawning is complete. Otoliths were not taken in all systems in all years to limit mortality of spawning adults. In years when otoliths are not collected, ages are assigned with river-specific age-length keys from previous years. Otoliths were not collected in the Roanoke River in 2016; the Tar-Pamlico River in 2015–2018 and 2021; the Neuse River in 2016, 2018, and 2022; and the Cape Fear River in 2015, 2016, 2018, and 2022. Additionally, ages of stocked fish determined using PBT analysis were used for ageing analysis of Roanoke River American shad in 2017–2022.

5.2.2 Independent Gill Net Survey

Each fish is measured for fork length and total length in millimeters. Starting in 2004, sex is determined for all fish captured from IGNS. Each fish is sexed by applying directional pressure to the abdomen toward the vent and observing the presence of milt or eggs or by dissection if dead. Scales are collected from the left side of each fish between the lateral line and the dorsal fin. Scales are prepared and aged according to the Cating (1953) method.

5.3 Total Mortality Estimates

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

5.4 Hatchery Evaluation

5.4.1 Roanoke River American shad Restoration Project

Nearly 78 million American shad fry were stocked in the Roanoke River between 1998 and 2018 (Table 8). The restoration stocking project was begun as mediation for highway construction that impacted spawning habitat on the upper Roanoke River and later was incorporated into the Federal Energy Regulatory Commission (FERC) relicensing of the Gaston and Roanoke Rapids hydropower projects. The goals of the project were to enhance the existing American shad population in the Roanoke River and to evaluate escapement of American shad stocked upstream of reservoirs to determine the benefits of future fish passage efforts. The majority of stocking occurred at Weldon, NC, which is downstream of all three mainstem dams, and fry were also stocked upstream of Kerr Dam (US Army Corps of Engineers), Gaston Dam (Dominion Power) and Roanoke Rapids Dam (Dominion Power).

In the early years of the restoration project, NCWRC followed protocols of other states involved in American shad restoration efforts and obtained broodfish for fry production from nearby rivers having adequate shad stocks. American shad broodfish were collected by electrofishing from the Tar-Pamlico, Neuse, Cape Fear, and Roanoke rivers from 1998–2010. From 2011 through 2018, only broodfish collected from the Roanoke River were utilized for production. Upon collection, broodfish were placed in circular tanks with oxygen and continuously circulating water onboard the electrofishing boats and were transferred to large circular, trailer-mounted tanks for transport to the

hatcheries. Hormone injection was used to initiate spawning in the hatchery from 1998 to 2008 but was not used to induce spawning from 2009 through 2018.

Annual contribution of hatchery-origin American shad to the Roanoke River population was evaluated for multiple cohorts of returning adults during the spring spawning runs and for out-migrating juveniles during fall of the stocking year. Evaluations were conducted using oxytetracycline (OTC) marks from 1998–2009. Subsequent testing proved OTC marking procedures and analyses were unreliable, and the NCWRC initiated use of genetic microsatellite markers for parentage-based tagging (PBT) methods in 2010. With the PBT method, each spawning tank contains a genetically discrete batch of broodfish, from which the progeny can be uniquely identified. Daily OTC marking techniques were not used after the switch was made to PBT analysis. Fin clips from adult American shad were collected during spawning stock surveys, and broodfish were also cross-referenced for potential hatchery contribution of stockings from previous years. Broodfish fin clips combined with fin clips collected during weekly samples were collectively referred to as at-large adults

Parentage-based-tagging efforts were initiated in 2010, but the early results (i.e., 2010–2014) could not capture potential hatchery contribution from year classes before 2010. Hatchery contribution of adult American shad collected on the Roanoke River spawning grounds was only 0.3% in 2012, 4.9% in 2013, and 12.7% in 2014. Hatchery contribution was underestimated and should be considered a minimum because few PBT cohorts were in the population prior to 2015.

Hatchery contribution increased as multiple cohorts of American shad that could be identified with PBT recruited into the population. Hatchery contribution of returning adults was 42.9% in 2015, 56.1% in 2016, 65.7% in 2017, and 71.3% in 2018. Staff from NCWRC were concerned about the increasing contribution of stocked fish that were produced by only a few broodfish each year. In addition to the high hatchery contribution, there were also population genetics concerns evidenced by decreasing effective population size estimates (Evans and McCargo 2019). Therefore, NCWRC staff decided to stop American Shad stocking in the Roanoke River after 2018. Hatchery contribution of returning adults was 64.2% in 2019 and decreased to 43.8% in 2021. Samples were not collected in 2020. Evaluations of returning adults will continue until stocked cohorts from 2010–2018 age out of the population or stocking resumes.

Hatchery contribution of adult samples from the Albemarle Sound was lower when compared with hatchery contribution on the spawning grounds. Only 3.4% of 2016 and 4.0% of 2017 samples were hatchery produced fish indicating that Roanoke River spawning fish do not make up the majority of the Albemarle stock and most of the fish tested were likely from the Chowan River. Additionally, contribution of stocked fish to outmigrating juveniles collected in the lower Roanoke River was also lower than the returning adults collected on the spawning grounds. From 2010 through 2018, hatchery contribution of juvenile collections ranged from 2.7% (2012) to 44.8% (2014). The results suggest that juveniles produced outside of the Roanoke River (most likely from the Chowan River) may be migrating into the lower Roanoke River and mixing with stocked and wild Roanoke River juvenile American shad.

5.4.2 Neuse River American Shad Restoration Project

The NCWRC began an American shad restoration stocking program in the Neuse River in 2012. The goal of the Neuse River American shad stocking program was to supplement the wild population by stocking fry produced from one spawning tank of approximately 100 broodfish each year. American shad broodfish were collected from the Neuse River near Goldsboro, NC, and were transported to Edenton National Fish Hatchery where they spawned in a large recirculating tank.

American shad fry were stocked at approximately 7-days of age in the Neuse River near Goldsboro, NC. Evaluation of hatchery contribution to the Neuse River American shad population is conducted using the same PBT methods as described for the Roanoke River restoration program. A total of 5,563,088 American shad fry were stocked in the Neuse River at the NC Hwy 117 bridge near Goldsboro, NC, from 2012–2018 (Table 9). Hatchery contribution to out-migrating juvenile samples was low (0–13%). Hatchery contribution to returning adults was also low (<10%). In 2016, which was the first-year hatchery fish were potentially available as age-4 adults, only 9 of 411 (4%) adults tested with PBT analysis were of hatchery-origin. Hatchery contribution increased slightly to 7.8% in 2017 and 9.3% in 2018 but decreased in 2019 (8.1%), 2020 (6.7%) and 2021 (4.3%). The fry stocking program was stopped after the 2018 stocking year. It appears the stocking program contributed very little to the overall American shad population in the Neuse River, and contribution of stocked fish should continue to decrease as stocked fish age out of the population.

6. FISHERY-DEPENDENT MONITORING

6.1 Commercial Fishery

6.1.1 Total Catch, Landings and Effort

American shad landings data are collected through the North Carolina Trip Ticket Program (NCTTP). The number of participants by gear utilized and the total number of positive trips can be determined. For the Albemarle Sound area, the following assumptions are made: (1) trips landing over 100 pounds of shad are considered directed trips, and (2) the maximum yardage used in directed trips is specific to the area and is described in Section 4.2. The total yardage for each area is determined by multiplying the number of directed trips by the maximum yardage per area. The catch-per-yard (CPY) is determined by dividing the number of pounds harvested by the total yardage estimate of gill nets fished. Multiplying by maximum yardage for each area will result in the pounds landed per targeted trip in that area. Catch estimates for other areas are determined similarly. For specific information regarding catch estimates, please see previous compliance reports.

6.1.2 Size, Age and Sex Composition of Catch

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

6.2 Recreational Fishery

6.2.1 Recreational Commercial Gear License Catch, Landings and Effort

The North Carolina Fisheries Reform Act of 1997 required the NCMFC to establish limits on recreational use of commercial fishing gear. An individual holding a Recreational Commercial Gear License (RCGL) can use limited amounts of specified commercial gear to catch seafood for personal consumption or recreational purposes. RCGL gill nets are limited to a maximum length of 100 yards (two or more RCGL holders may possess up to 200 yards) and must comply with all proclamations with respect to this gear. The holder of the RCGL must comply with the recreational size and creel limits, and RCGL catch cannot be sold. During 2002, NCDMF began a RCGL survey to estimate the harvest by these license holders. The survey was discontinued in 2009 due to budget reductions. The total number of RCGLs issued has been on a steady decline since first established in 2001 (6,356 RCGL sold). Total sales in 2021 (2,143 RCGL sold) are well below

total sales from the early 2000s (NCDMF 2021). Landings from this gear are unknown but are assumed minimal.

RCGL general guidelines and rules summary can be found here: NCDMF RCGL General Guidelines and Rules Summary May 12, 2020.

6.2.2 Roanoke River Catch, Landing, and Effort

An annual creel survey occurs on the Roanoke River each year. The survey targets striped bass catch and effort but also collects information on American shad and other species, although American shad catch is low due to the fishing method. Therefore, these data have not been incorporated into sustainability parameters for the Albemarle Sound-Roanoke River. Additional information with respect to this creel survey can be found in Section 7.3.

6.2.3 Central Southern Management Area Catch, Landings, and Effort

The Tar-Pamlico, Neuse and Cape Fear rivers are collectively known as the Central Southern Management Area (CSMA). The CSMA was originally established for purposes of estuarine striped bass management and includes all Internal Coastal, Joint, and contiguous Inland Fishing Waters of North Carolina south of a line from Roanoke Marshes Point across to Eagle Nest Bay to the South Carolina state line. A comprehensive creel survey to identify and estimate recreational American shad and hickory shad effort and catch was initiated in 2012 within the Tar-Pamlico River and Neuse River and in 2013 within the Cape Fear River. Prior to 2012, creel surveys were conducted on these systems on a rotating basis with only one river basin surveyed each spring. The 2023 SFP proposes sustainability parameters utilizing the confirmed harvest estimates of American shad (numbers of fish) from the CSMA creel survey for the Tar-Pamlico River, Neuse River, and Cape Fear river systems.

The Neuse River basin drains over 6,200 square miles of land with over 3,000 miles of streams and rivers. The mouth of the main channel is six miles across – the widest in the United States. Over 1.3 million residents reside within this river basin. Major tributaries include Crabtree, Swift, and Contentnea creeks, along with the Eno, Little, and Trent rivers. Survey points included 45 boat ramps and fishing access points from Milburnie Park in East Raleigh to Lee's Landing on Broad Creek. The river was divided into three segments, with all access points in Goldsboro and above classified as the upper zone, sites on Contentnea Creek and downstream from Goldsboro to Core Creek were considered the middle zone, and those downstream from Core Creek, the lower zone. Prior to 2012, the Neuse River was comprised of only two zones with all sites above Contentnea Creek considered the upper.

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

The Cape Fear River is the southernmost river within the CSMA and flows approximately 199 miles from its confluence of the Deep and Haw rivers to the Atlantic Ocean. The Cape Fear River basin, the largest watershed entirely in North Carolina, encompasses 9,300 square miles. In addition to the Deep and Haw rivers, other major tributaries include the Black River and Northeast

Cape Fear River. Creel surveys were conducted by NCWRC personnel to estimate recreational fishery statistics for American shad in 2002 and 2011, and NCDMF staff assumed responsibility for annual creel surveys in 2013. Estimates from the NCWRC survey in 2011, prior to the implementation of the full survey in 2013, were used in the calculation of relative *F* described in Section 9.4.2. In 2002 and 2011, boat and bank anglers were interviewed from March through May only at the three lock and dam access points during the NCWRC creel surveys. In 2013, the creel survey was expanded from the lock and dams to include five boat ramps and access sites, with a sixth site added in 2014 surveyed from February–March. Access points surveyed now include nine sites from Castle Hayne, NC on the Northeast Cape Fear River to Fayetteville, NC, the upper most site on the Cape Fear River.

6.2.3.1 Sampling Procedures

Recreational fishing statistics from the CSMA were calculated through a non-uniform stratified access-point creel survey (Pollock et al. 1994). Site probabilities were set in proportion to the likely use of the site according to time of day, day of the week, and season. Probabilities for this survey were assigned based on both boat and bank angler effort for fishermen targeting shad. For the creel survey in the Roanoke River probabilities were based on boat angler use due to the low level of bank angling during the spring months. It should be noted, however, that the Roanoke River angler survey is designed to specifically target striped bass effort and catch, therefore survey estimates are not considered for the shad fishery and are simply observations.

For the CSMA, probabilities were adjusted during the survey period according to angler counts to provide more accurate estimates. Morning and afternoon periods were assigned unequal probabilities of conducting interviews, with each period representing half a fishing day. A fishing day was defined as the period from one hour after sunrise until one hour after sunset. Monthly sampling periods for each river and zone were stratified accordingly, and all weekend and holiday dates along with two randomly selected weekdays were chosen from each week for sampling.

Anglers in the upper zone of the Tar-Pamlico River were interviewed throughout the spring months (January–May), while anglers in the lower zone were interviewed year-round based on the evidence of a year-round fishery and no seasonal closures. Two creel clerks were assigned to this river, with one surveying the upper zone January through May and one clerk surveying the lower zone from January through December. The three zones within the Neuse River were covered with one creel clerk per zone. The lower zone was surveyed from January to December while middle zone surveys were conducted January–May and the upper zone surveys from February–May. The Pungo River was surveyed throughout the year with one creel clerk. Beginning in 2013, the Cape Fear River was included in the survey from February–March with one creel clerk.

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

6.2.3.2 Analysis

6.2.3.2.1 Effort and Catch Estimations

A fishing day was defined as the period from one hour after sunrise until one hour after sunset. The effort calculation was made by calculating estimates for each day sampled by day type (week and weekend day). This is accomplished by summing the total number of targeted shad species trips for the sample day and dividing by the selection probability for the site. The mean estimates for each day type are expanded to the final estimate by dividing the total number of days by the number of days sampled. For this survey, effort was calculated from those anglers indicating "American shad, hickory shad, and miscellaneous shad (non-specific shad) as a target species.

Samples were reduced to shad species effort and catch only. Results were stratified by river, access point, and time of day. Catch was defined as the sum of harvested fish and discarded fish. Discarded fish equaled the sum of fish caught in excess of creel limits (over-creel), legal-sized fish caught and released, and sub-legal fish returned to the water. Daily effort and catch for each river were calculated by expanding observed numbers by the sample unit probability (time of day probability divided by access area probability). Total catch estimates for the CSMA and catch estimates for each zone and type of day were calculated based on the Horvitz-Thompson estimator (NCDMF 2021).

Estimated CPUE values were obtained by dividing estimated catch by estimated shad spp. trips as well as angler hours in order to identify trends in fishing pressure and angler success. Size structure of shad spp. in harvests was described for each zone using length-frequency distributions of observed samples. Fishing party characteristics and methods used during shad spp. trips reported by anglers were documented by river and day type.

A database was created using Access© and statistical analyses were performed with SAS 9.1©. Beginning in 2012, the NCWRC Portal Access to Wildlife Systems (PAWS) was used to house these data and estimate effort and catch. NCDMF and NCWRC staff have been verifying calculations to ensure consistency with the previous work. Recreational creel survey estimates of shad species for the Tar-Pamlico, Neuse, and Cape Fear river systems from 2012–2022 (2013–2022, Cape Fear) are listed in Table 2, Table 4, and Table 6 of this document.

6.2.3.2.2 Angler Demographics and Economic Analysis

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

6.3 Bycatch and Discards

Bycatch and discard information are not currently collected on commercial trip tickets. The only mechanism that exists to capture commercial bycatch and discards of American shad in other fisheries is an observer program conducted by NCDMF primarily to monitor sea turtle and sturgeon interactions in gill nets, as required under the Incidental Take Permits (ITP) for both. A state-wide sea turtle ITP was approved in September 2013 followed by an Atlantic Surgeon ITP in

July 2014. Prior to the approval of the Sturgeon ITP there was limited observer coverage in the Western Albemarle Sound and the rivers when the directed American shad fishing season occurs. Observer coverage has increased in recent years in the American shad fishery, under the Sturgeon ITP because encounters with sturgeon in these areas and times of year are more common. Even though observer coverage has historically been limited where American shad are typically targeted, gear, area, and seasonal restrictions are thought to have kept shad discards relatively low.

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

7. ALBEMARLE SOUND-ROANOKE RIVER

7.1 Stock Status

The 2020 ASMFC benchmark stock assessment stated American shad stocks in the Albemarle Sound were not experiencing overfishing, as the terminal year fishing mortality in 2017 was 0.49 (90% CIs of 0.30-0.67), which is below the $F_{40\%}$ threshold (1.71). The stock is not overfished, as the terminal year spawning stock abundance in 2017 was 48 metric tons (90% CIs of 39.6-66.0 metric tons) which is above the $SSB_{40\%}$ threshold (42 metric tons).

7.2 Commercial Fisheries

The Albemarle Sound area has traditionally accounted for the largest proportion of the state's commercial harvest (Figure 4). Since 2001, American shad landings from the Albemarle Sound area accounted for over 50% of the total American shad harvest in North Carolina. Landings from gill nets comprised over 90% of the overall harvest across the same time period. The commercial fishery primarily occurs in Albemarle Sound and within the Chowan River tributary. Commercial effort and harvest are minimal in the Roanoke River. From 1994 to 2022 only 72 pounds of American shad were landed from commercial fisheries in the Roanoke River, with no reported harvest since 2017. Commercial harvest from the Roanoke River is limited to pound nets because - anchored and drift gill nets have been prohibited since 1991 and 1993 respectively.

7.3 Recreational Fisheries

Recreational fisheries for striped bass and hickory shad have existed on the Roanoke River for many years, but little effort, catch or harvest of American shad have been documented in annual creel surveys. However, creel surveys conducted by the NCWRC have traditionally focused on striped bass effort and harvest; therefore, estimates of American shad harvest could be underestimated. The spring 2006 Roanoke River creel report estimated a directed harvest of 103 American shad and release of 541 fish, but the harvest estimate was expanded from only seven observations (McCargo et al. 2007). Annual estimates of American shad harvest have not been calculated for the Roanoke River fishery since 2006 when the ASMFC suspended the recreational harvest reporting requirements. Additionally, little to no focused recreational effort for American shad occurs in the Albemarle Sound or tributaries, including the Roanoke River, as most effort is focused on striped bass. American shad are most likely targeted by bank anglers in the Roanoke River, however anecdotal evidence from NCWRC biologists and enforcement officers indicates American shad catch and harvest on the Roanoke River is minimal. NCWRC has not been able to expand the Roanoke River creel survey to include bank anglers due to limited staff availability and funding. The existing creel survey conducted by NCDMF in the Albemarle Sound and tributaries other than the Roanoke River also targets striped bass anglers, but recreational American shad harvest is rarely documented. Despite the shortcomings of North Carolina creel surveys for

estimating American shad effort and harvest, directed recreational effort for American shad is minimal because most recreational fisheries occur on the spawning grounds, most of which occur in Virginia portions of Chowan River tributaries. Recreational harvest from these tributaries, including Virginia portions of the Meherrin, Nottaway, and Blackwater rivers, that drain into the Chowan River is unknown. Through recent tagging data (see Section 5.1.2.4 for additional detail) we know that a large portion of American shad are ascending the Chowan River, instead of the Roanoke River, to reach spawning grounds located in these Virginia systems. Additional cooperation between both Virginia and North Carolina is needed to properly evaluate the impact of the recreational fishery to the Chowan River spawning stock, but recreational harvest has been prohibited since January 1, 2019, in all waters of Virginia.

7.4 Sustainability Parameters

The sustainability parameters selected for Albemarle Sound-Roanoke River were juvenile abundance index, female CPUE based on the IGNS, female CPUE based on the electrofishing survey and female relative *F* based on the IGNS. Data used in the development of sustainability parameters for the Albemarle-Roanoke River system include juvenile data collected by NCDMF (Section 5.1.1), IGNS data collected by NCDMF (Section 5.1.2.2), electrofishing data collected by NCWRC (Section 5.1.2.1.2), and commercial harvest data collected through the NCTTP (Section 6.1).

Relative *F* based on the IGNS was chosen over relative *F* based on the electrofishing survey because the electrofishing survey is limited to the Roanoke River and was not considered representative of Albemarle Sound as a whole and as previously noted, most American shad in this system are likely ascending the Chowan River. The IGNS occurs in the same areas of the Albemarle Sound as the commercial fishery, the calculation of relative *F* based on the IGNS rather than the electrofishing index was determined to be more appropriate. Exceeding the threshold for three consecutive years for Juvenile Abundance, Female CPUE (IGNS), or Female Relative *F* (IGNS*)* will trigger management action. Female CPUE (electrofishing survey) will be used in conjunction with a second index for triggering management action (see Section 14 for additional detail).

Results from recent telemetry studies indicate a substantial portion of American shad tagged in the Albemarle Sound migrate up the Chowan River and into the Meherrin and Nottaway rivers, with no tag detections in the Blackwater River (Mack et. al. 2021). American shad are collected in all three Chowan River tributaries during electrofishing surveys conducted by Virginia Department of Wildlife Resources staff, but the infrequent nature of the surveys prevents development of sustainability parameters with the data. While more research into the contribution from these systems is needed, it appears the Chowan River tributaries are important spawning areas for American shad entering the Albemarle Sound (See Section 5.1.2.4 for additional detail).

7.4.1 Juvenile Abundance

Juvenile Abundance: The relative abundance index of juvenile American shad, expressed as CPUE, based on the NCDMF Juvenile Seine Survey, is calculated as the number of fish per haul using data collected from 14 individual stations from June through October in the western Albemarle Sound (Figure 5).

- Time series: 1996–2022
- Index Value: annual, arithmetic mean

- Threshold: 25th percentile (where 75% of all values are greater) from the fixed time series 1996–2021
- Trigger: Three consecutive years of values below the threshold.

The juvenile abundance index has been above the threshold since 2013 (Figure 5). This index has demonstrated an overall increase since 2014 which corresponds to the management action taken under the 2013 SFP reducing commercial harvest from the Albemarle Sound. Index value for 2022 is preliminary.

7.4.2 Female CPUE (electrofishing survey)

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

- Time series: 2001–2022 (no survey data available for 2020)
- Index Value: annual, ratio estimator
- Threshold: 25th percentile (where 75% of all values are greater) from the fixed time series 2001–2017.
- Trigger: Three consecutive years of values below the threshold. Does not trigger management unless coupled with another sustainability parameter.

Electrofishing surveys for American shad were incomplete in 2020 due to limitations resulting from the Covid-19 pandemic and resumed as usual in 2021. The ASWG reviewed the data and recommended retaining the baseline fixed time-series of 2001–2017, established in the 2018 SFP, to determine the threshold value for the sustainability parameter.

The female abundance index derived from the electrofishing survey was above the threshold throughout most of the time series, except for 2006, 2010, and 2016 (Figure 6). This index demonstrated an increase from 2006 to 2008, decreased slightly in 2009 and dropped below the threshold in 2010. The index then increased through 2014 to the highest value of the time series, before declining to below the threshold in 2016, and increasing again in 2017. The index has remained above the threshold since 2017.

7.4.3 Female CPUE (IGNS)

Female CPUE (IGNS): The female CPUE index based on the Albemarle Sound IGNS was calculated as the number of fish per haul using data collected from float gill nets fished in Zone II, January through May (Figure 7).

- Time series: 2000–2022. Although the IGNS has been conducted since 1991, use of the 2000–2022 time series will allow for more consistent comparison with the female CPUE index from the Roanoke River electrofishing survey, which has been conducted annually since 2000. See explanation below, IGNS data not available for 2020 or 2021.
- Index Value: annual, arithmetic mean
- Threshold: 25th percentile (where 75% of all values are greater) of the index (January–May, float gill nets, Zone II) from the fixed time series 2000-2017.
- Trigger: Three consecutive years of values below the threshold.

The Albemarle Sound IGNS was suspended in February 2020 due to a combination of factors including the Covid-19 pandemic and initiation of consultation to update ESA permit requirements described Section 5.1.2.2. Sampling resumed in November 2021. The ASWG reviewed the data

and recommended retaining the baseline fixed time-series of 2000–2017, established in the 2018 SFP, to determine the threshold value for the sustainability parameter.

The IGNS index of female relative abundance for Albemarle Sound has shown slight variation over time and was below the threshold starting in 2011 for three consecutive years, triggering management action in 2014. Since 2013, the index has been below the threshold for two, non-consecutive years (2017 and 2022) (Figure 7).

7.4.4 Female Relative *F* (IGNS)

Female Relative F (IGNS): Female relative *F* (pounds) based on the Albemarle Sound IGNS was calculated using commercial harvest data of roe shad, all gear types, from the Albemarle Sound (February through April, 2000-2013; March, 2014–2022) and the female CPUE index (January–May, float gill nets, Zone II) from the Albemarle Sound IGNS (Figure 8).

- Time series: 2002–2022. Same time series disruption in 2020 and 2021 described for female CPUE (IGNS) above apply to Female Relative *F*.
- Index Value: Calculated by dividing annual commercial landings by a hind cast 3-year average of a survey index (current year + previous two years).
- Threshold: 25th percentile (where 75% of all values are greater) from the fixed time series 2002–2017.
- Trigger: Three consecutive years of values above the threshold.

Relative *F* is computed by dividing annual commercial landings by a hind cast 3-year average of a fishery independent index (Albemarle Sound IGNS). Whereas the 2013 SFP used a centered 3-year average, the hind cast 3-year average ensures the value of the final year in the time series (which can trigger management action) remains unchanged once calculated. A 3-year average was chosen to dampen the noise of the survey index in place of point estimates in the denominator. Indices of relative abundance and estimates of relative *F* were calculated for each system through 2022. Thresholds (75th and 25th percentiles) for sustainability parameters were fixed using survey data through 2017. The ASWG reviewed the data and recommended retaining the baseline fixed time-series of 2002–2017, established in the 2018 SFP, to determine the threshold value for the sustainability parameter.

Estimates of female relative *F* derived from the Albemarle Sound IGNS have varied with time. The index was above the threshold in 2003, 2007, 2012, and 2013. Relative *F* could not be estimated in 2020 and 2021 because of the Albemarle Sound IGNS survey suspension. To calculate the 2022 relative *F*, data from 2018 and 2019 IGNS were used in the hind cast 3-year average as a proxy for 2020 and 2021. Under the 2023 SFP, the relative *F* threshold has not been above the threshold for three consecutive years. This is attributed to reducing the variability in the point estimates for relative *F* from the fishery-independent index. The 2023 SFP relative *F* does not constrain the Albemarle Sound IGNS (fishery-independent index) to the mesh size and season of the commercial fishery. Unlike previous SFPs, relative *F* for the Albemarle Sound is now calculated using the female CPUE index, which is also a sustainability parameter, and commercial harvest of roes from all gear types. These modifications were necessary to capture the change in the commercial fishery due to management restrictions as well as changes in sampling methodology to the Albemarle Sound IGNS (removal of sink gill nets). The modifications to the relative *F* calculation are more representative of the American shad abundance observed in the fishery-independent and fishery-dependent data.

In the 2013 SFP, the Albemarle Sound IGNS for the Albemarle Sound-Roanoke River was truncated to represent the commercial season, February through April (2000–2012) and data only from the 5.0, 5.5, and 6.0 inch stretched mesh sizes. The mesh sizes selected most accurately reflect those used by the commercial gill net fleet, harvest of American shad from other gears were not incorporated into relative *F*. In 2014 management action was triggered under this SFP and the commercial season was reduced to March 3 through March 24. This season has been maintained through 2022.

The 2018 SFP, maintained the female relative *F* calculation based on the Albemarle Sound IGNS subset to the season and mesh sizes of the commercial gill net fleet. The Albemarle Sound IGNS was subset to the month of March for female relative *F* calculation from 2014 to 2022. This has increased the variability in the point estimates for relative *F* and reduced the sample size used in the IGNS index. The index exceeded the threshold in 2011 through 2014 and remained below the threshold from 2015 through 2022. However, for 2020 and 2021 relative *F* was not estimated due to lack of a survey index. The 2022 relative *F* value is calculated using 2018 and 2019 survey index data as a proxy for 2020 and 2021 due to lack of survey index.

7.5 Areas Covered by Sustainability Parameters

Monitoring and sustainability parameters in the Albemarle Sound-Roanoke River are representative of the entire Albemarle Sound, and all its tributaries. Principal tributaries of the Albemarle Sound include the Chowan River basin (Meherrin, Nottoway, and Blackwater rivers) and the Roanoke River basin including the Cashie and Eastmost rivers. Monitoring in the Albemarle Sound-Roanoke River is also representative of the Currituck, Roanoke, and Croatan sounds and the tributaries thereof. The Currituck Sound connects to the Albemarle Sound from the northeast near the coast and includes Northwest and North Landing rivers. Croatan and Roanoke sounds join the Albemarle Sound from the southeast, which joins the Pamlico Sound and empties into the Atlantic Ocean via Oregon Inlet. Remaining tributaries of the Albemarle Sound include Alligator River, Scuppernong River, Mackeys Creek, Salmon Creek, Edenton Bay, Yeopim River, Perquimans River, Little River, Big Flatty Creek and Pasquotank River.

Fishery-independent monitoring is performed throughout the Albemarle Sound, including the western tributaries and the Currituck, Roanoke, and Croatan sound through fishery-independent gill net, trawl, and seine surveys (see Section 5.1.2 for more details). Only fishery-independent data from the western portion of the Albemarle Sound and Roanoke River are used to develop the sustainability parameters. The primary spawning rivers for American shad entering the Albemarle Sound are the Chowan River and Roanoke River systems. Monitoring and sustainability parameters inform management of all tributaries. It is important to note that while fishery-independent monitoring outside of the western Albemarle Sound is not used to calculate sustainability parameters, monitoring of adults and juveniles are occurring in an effort to track trends in abundance. Management measures taken as a result of sustainability plan triggers will be implemented throughout all Albemarle Sound and its tributaries in addition to the Currituck, Roanoke, and Croatan sounds.

Fishery-dependent data are monitored by the NCTTP which collects trip level commercial harvest data for the entire Albemarle Sound. Specific waterbody locations within the Albemarle Sound can be recorded on the trip ticket to monitor if harvest is increasing in a particular area, that may require additional monitoring.

7.6 Additional Considerations

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

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

8. TAR-PAMLICO RIVER

8.1 Stock Status

Stock status could not be determined for the Tar-Pamlico River based on the 2020 ASFMC stock assessment (ASMFC 2020). Juvenile mortality status was unknown due to lack of data. Adult mortality status was unknown due to lack of data to estimate female mortality in 2017, the terminal year of the assessment. Additionally, the delay-difference model experienced diagnostics problems

and could not be used for status determination. The most recent three-year average of female total mortality was 0.87 in 2007 which is below the $Z_{40\%}$ threshold (1.07).

8.2 Commercial Fisheries

Commercial landings of American shad have declined significantly since the mid-1980s and have remained low and variable without trend since 1994 (Figure 4). Almost all harvest occurs in gill nets upstream of the ferry lines from the Bayview to Aurora Ferry. Since a 2019 prohibition of all gill nets above the ferry lines, commercial harvest from this system has been negligible.

8.3 Recreational Fisheries

A recreational fishery does exist and estimates of angler effort and catch are calculated using creel surveys. The recreational daily creel limit for the Tar-Pamlico is 10 American and hickory shad in the aggregate. Before 2012, these surveys rotated among the Tar-Pamlico, Neuse, and Cape Fear rivers. Annual creel surveys coordinated between both NCDMF and NCWRC jurisdictions began in 2012 on the Tar-Pamlico and Neuse rivers, and on the Cape Fear River in 2013. Estimates of angler effort and catch are calculated through creel surveys described in the fishery-dependent, Section 6.2, of this plan.

A confounding factor in the creel survey is that anglers may indicate they targeted "shad" or miscellaneous shad (non-specific shad species), because American and hickory shad co-occur in the Tar-Pamlico River. The confirmed catch of American shad can be estimated based on anglers that confirmed targeting or catching American shad. For example, the 2022 Tar-Pamlico creel survey determined recreational anglers harvested 464 American shad and took 201 targeted trips, 806 hickory shad and took 0 targeted trips, and 111 miscellaneous shad and took 5,444 targeted trips. Trip and effort estimates for specific shad species is calculated from anglers that indicate target species as American shad, hickory shad, or miscellaneous shad. Catch estimates are based on the shad species caught as indicated by the angler or observed by the creel clerk. For 2022, anglers did not indicate targeting of hickory shad, but the catch of hickory shad was either confirmed or observed by the angler, therefore the trip and effort estimates for hickory shad were zero (Table 2).

8.4 Sustainability Parameters

The sustainability parameters selected for the Tar-Pamlico River system were the female CPUE index and female relative *F*. Exceeding the threshold for any of the selected parameters for three consecutive years will trigger management action (see Section 14 for additional detail).

Data used in the development of sustainability parameters for the Tar-Pamlico system include electrofishing data collected by NCWRC (Section 5.1.2.1.2), commercial harvest data collected through the NCTTP (Section 6.1), and recreational harvest data collect through the CSMA Creel Survey (Section 6.2.3). There is no directed long-term juvenile abundance survey for the Tar-Pamlico system. An IGNS has been conducted consistently in the Tar-Pamlico, Pungo, and Neuse river tributaries of Pamlico Sound since 2004, but these data are not suitable for sustainability parameters due to low catch rates of American shad (Section 5.1.2.3).

8.4.1 Female CPUE (electrofishing survey)

Female CPUE (electrofishing survey): The female CPUE index based on the NCWRC electrofishing survey was calculated as the number of fish per minute using data collected from March through May (Figure 9).

- Time series: 2000–2022 (no survey data available for 2020)
- Index Value: annual, ratio estimator

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

Electrofishing surveys for American shad were incomplete in 2020 due to limitations resulting from the Covid-19 pandemic and resumed as usual in 2021. The ASWG reviewed the data and recommended retaining the baseline fixed time-series of 2000–2017, established in the 2018 SFP, to determine the threshold value for the sustainability parameter.

Female relative abundance of American shad derived from the electrofishing survey in the Tar-Pamlico River has been relatively stable over the time series except for two notably high years in 2003 and 2004. The index was below the threshold in 2006, 2007, 2009, 2018, and 2019 but above the threshold in all other years. No index was available in 2020.

8.4.2 Female Relative *F* (electrofishing survey)

Female Relative F (electrofishing survey): Female relative *F* (fish) based on the NCWRC electrofishing survey was calculated using the combined commercial and recreational harvest from the Tar-Pamlico River and the female CPUE index from the Tar-Pamlico River electrofishing survey (Table 3, Figure 10).

- Time series: 2012–2022 (no survey data available for 2020)
- Index Value: Calculated by dividing annual combined commercial and recreational harvest (fish) by a hind cast 3-year average of a survey index (current year + previous two years).
- Threshold: 75th percentile (where 25% of all values are greater) from the fixed time series 2012–2022.
- Trigger: Three consecutive years of values above the threshold.

Relative *F* is computed by dividing the combined commercial and recreational harvest (fish) by a hind cast 3-year average of a fishery-independent index (female CPUE, electrofishing survey). A 3-year average was chosen to dampen the noise of the survey index in place of point estimates in the denominator. American shad commercial harvest is reported in pounds whereas the confirmed recreational harvest of American shad is reported in numbers of fish. For the relative *F* calculation, commercial harvest data were converted to numbers of fish using average weight data collected by NCDMF from this sector. Indices of relative abundance and estimates of relative *F* were calculated for each system through 2022. Thresholds (75th and 25th percentiles) for sustainability parameters were fixed using survey data through 2022. Note that the 2012 index value is utilizing female CPUE index data from 2010–2012 in the hind cast 3-year average. Under the 2023 SFP, female relative *F* estimates were above the threshold in 2012, 2013, and 2017. Since 2018, the index has remained below the threshold. Due to the lack of survey data for 2020, only two years of the survey index are used in the hind cast 3-year average for the relative *F* estimates from 2020 through 2022.

To calculate relative *F* in numbers of fish, American shad commercial harvest data (pounds) from 2012–2022 for all gears, February through April, were separated into two market grades: roe and buck. Roe includes all market grades except for buck and unclassified (i.e., small, medium, large, jumbo). Roe and buck harvest were combined, and the percent of roe and buck determined. These percentages were applied to the unclassified market grade and added to the total harvest of roe and buck. Individual weight data collected from the Tar-Pamlico River commercial fishery (2000–2017) was used to calculate and average individual fish weight for female (3.711 lb/roe) and male (2.726 lb/buck). These individual weight estimates were applied to the total commercial harvest for each year to obtain the estimated numbers of fish by market grade. The estimated number of fish

for buck and roe were combined, annually, representing the total commercial harvest in numbers of fish. The commercial harvest numbers were added to the recreational harvest numbers (confirmed American shad) to equal the numerator in the calculation of relative *F*. The denominator of the relative *F* calculation is a hind cast 3-year average of the female CPUE sustainability parameter using 2010–2022 index values. The female CPUE sustainability parameter is being used in the calculation of female relative *F* to reduce variability in point estimates, whereas previous SFPs truncated this index.

In the 2013 SFP, the female CPUE for the Tar-Pamlico River was truncated to represent the commercial season, March through April (2000–2017). Truncating the female CPUE to the March through April has increased the variability in the point estimates for relative *F* and reduced the sample size. The threshold for this plan was not fixed and changed with a new year of data. In 2017, the terminal year of the 2013 SFP, the female relative *F* index was above the threshold in 2000, 2005, 2007, 2009, and 2012.

The 2018 SFP, maintained the female relative *F* calculation based on the truncated female CPUE but fixed the time-series of data used to calculate the threshold to 2002–2017. Estimates of relative *F* for female American shad derived from the electrofishing survey and commercial harvest were above the threshold during 2007 to 2009. These estimates of female relative *F* remained below the threshold through 2022 as the commercial harvest declined. Due to the lack of survey data for 2020, only two years of the survey index are used in the hind cast 3-year average for the relative *F* estimates from 2020 through 2022.

8.5 Areas Covered by Sustainability Parameters

Monitoring and sustainability parameters in the Tar-Pamlico River are representative of the entire Tar-Pamlico River basin, including tributaries. Management measures taken as a result of sustainability plan triggers will be applied at the basin level and will include all tributaries.

8.6 Additional Considerations

There is potential to improve upstream passage in this system. The NCWRC, USFWS, Pamlico-Tar River Foundation, and the Albemarle Pamlico National Estuary Partnership have engaged in conversations with the Rocky Mount Mills Dam owner and hydroelectric operator. In addition to interest in providing American shad access to potential spawning habitat upstream of Rocky Mount Mills Dam, concern exists that hydropeaking operations (periodic spikes in flow) at Rocky Mount Mills Dam compromise the quality of existing spawning habitat. The dam owners agreed to cease hydropeaking during the anadromous spawning season. The powerhouse has been out of operation for several years, but the current owners of the dam have intentions to resume hydroelectric operation and are considering fish passage improvements, which would open approximately 3.5 miles of additional spawning habitat. Also, Rocky Mount Mills Dam is a run-of-the river dam with limited storage capacity and is not FERC regulated as it meets certain exemption requirements.

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

As noted previously, NCDMF develops an annual list of research priorities for commercially and economically important species. One of the top priorities has consistently been expansion of existing surveys to provide accurate juvenile abundance indices (JAI) for all commercially and recreationally important species. In 2019, NCDMF expanded the juvenile seine survey (Program

100) to the Tar-Pamlico, Neuse, and Cape Fear river systems. The survey is operated using the same gear and time frame as described in Section 5.1.1 for the Albemarle Sound. While the seine survey was expanded primarily for striped bass, river herring and shad may also be intercepted as the survey is conducted in known anadromous spawning areas. Due to the short time-series, this data was not evaluated for the 2023 SFP but will be evaluated under the next 5-year SFP.

9. NEUSE RIVER

9.1 Status of Stocks

The overall stock status could not be determined for the Neuse River based on the 2020 ASFMC stock assessment (ASMFC 2020). Juvenile mortality status is unknown due to lack of data. Adult mortality status is considered sustainable as the three-year average catch in 2017 was less than the delay-difference model median total allowable catch (TAC) estimate of 51,600 pounds. Abundance status is unknown due to lack of juvenile data. There have been conflicting trends in adult abundance since 2005, with an increasing trend detected from the electrofishing survey and no trend detected from the commercial harvest.

9.2 Commercial Fisheries

Commercial landings of American shad have declined since 1972. There have been several peaks throughout the time series, but landings have remained low and variable without trend since the early 2000s (Figure 2). Harvest occurred almost entirely from gill nets upstream of the ferry lines from the Minnesott Beach and Cherry Branch ferry. Since the 2019 gill net prohibition above the ferry lines, commercial harvest from this system has been negligible.

9.3 Recreational Fisheries

Estimates of angler effort and catch are calculated through creel surveys noted in the fishery-dependent, Section 6.2, of this plan. Like the Tar-Pamlico River a confounding factor of the Neuse River creel survey is that anglers may indicate they targeted “shad” or non-specific shad species, because American and hickory shad co-occur in the Neuse River. The confirmed catch of American shad can be estimated based off anglers that confirmed targeting or catch of American shad. A 1-fish daily limit on American shad within the aggregate 10-fish recreational creel limit for American and hickory shad has been implemented in Coastal, Joint, and Inland Fishing Waters of the Neuse River. With the 1-fish daily limit most American shad caught in the recreational fishery are harvested. The 2022 Neuse River creel survey determined recreational anglers harvested 36 American shad and took 22 targeted trips, 4,033 hickory shad and took 65 targeted trips, and 0 miscellaneous shad and took 6,129 targeted trips (Table 4). Trip and effort estimates for specific shad species is calculated from anglers that indicate target species as American shad, hickory shad, or miscellaneous shad. Catch estimates are based on the shad species caught as indicated by the angler or observed by the creel clerk.

9.4 Sustainability Parameters

The sustainability parameters selected for the Neuse River system were the female CPUE index and female relative *F*. Exceeding the threshold for any of the selected parameters will trigger management action (see Section 14 for additional detail).

Data used in the development of sustainability parameters for the Neuse River system include electrofishing data collected by NCWRC (Section 5.1.2.1.2), commercial harvest data collected through the NCTTP (Section 6.1), and recreational harvest data collect through the CSMA Creel Survey (Section 6.2.3). There is no directed long-term juvenile abundance survey for the Neuse River system. An IGNS has been conducted consistently in the Tar-Pamlico, Pungo, and Neuse

river tributaries of Pamlico Sound since 2004, but these data are not suitable for sustainability parameters due to low catch rates of American shad (Section 5.1.2.3).

9.4.1 Female CPUE (electrofishing survey)

Female CPUE (electrofishing survey): The female CPUE index based on the NCWRC electrofishing survey was calculated as the number of fish per minute using data collected from March through May (Figure 11).

- Time series: 2000–2022 (no survey data available for 2020)
- Index Value: annual, ratio estimator
- Threshold: 25th percentile (where 75% of all values are greater) from the fixed time series 2000–2017.
- Trigger: Three consecutive years of values below the threshold.

Electrofishing surveys for American shad were incomplete in 2020 due to limitations resulting from the Covid-19 pandemic and resumed as usual in 2021. The ASWG reviewed the data and recommended retaining the baseline fixed time-series of 2000–2017, established in the 2018 SFP, to determine the threshold value for the sustainability parameter.

Female relative abundance of American shad derived from the electrofishing survey in the Neuse River has been variable and remained above the threshold for ten out of the past 12 years (2011–2022). The index was below the threshold in 2000, 2002, 2006, 2007, 2010, and 2022. The 2022 index may be explained by a relatively dry spring preventing sampling in the Neuse River above Raleigh, NC (T.D. VanMiddlesworth, NCWRC, personal communication).

9.4.2 Female Relative *F* (electrofishing survey)

Female Relative F (electrofishing survey): Female relative *F* (fish) based on the NCWRC electrofishing survey was calculated using the combined commercial and recreational harvest from the Neuse River and the female CPUE index from the Neuse River electrofishing survey (Table 5, Figure 12).

- Time series: 2012–2022 (no survey data available for 2020)
- Index Value: Calculated by dividing annual combined commercial and recreational harvest (fish) by a hind cast 3-year average of a survey index (current year + previous two years).
- Threshold: 75th percentile (where 25% of all values are greater) from the fixed time series 2012–2022.
- Trigger: Three consecutive years of values above the threshold.

Relative *F* is computed by dividing the combined commercial and recreational harvest (fish) by a hind cast 3-year average of a fishery-independent index (female CPUE, electrofishing survey) as described in Section 8.4.2 for Tar-Pamlico River system. To convert commercial harvest to numbers of fish, individual weight data collected from the Neuse River commercial fishery (2000–2017) was used to calculate average individual fish weight for female (3.635 lb/roe) and male (2.293 lb/buck). Under the 2023 SFP, female relative *F* estimates were above the threshold in 2012, 2013, and 2014. Since 2015, the index has remained below the threshold. Due to the lack of survey data for 2020, only two years of the survey index are used in the hind cast 3-year average for the relative *F* estimates from 2020 through 2022.

In the 2013 SFP, the female CPUE for the Neuse River was truncated to represent the commercial season, March through April (2000–2017). Truncating the female CPUE to the March through April has increased the variability in the point estimates for relative *F* and reduced the sample size.

The threshold for this plan was not fixed and changed with a new year of data. In 2017, the terminal year of the 2013 SFP, the female relative *F* index was above the threshold in 2002, 2003, 2006, and 2007.

The 2018 SFP, maintained the female relative *F* calculation based on the truncated female CPUE but fixed the time-series of data used to calculate the threshold to 2002–2017. Estimates of relative *F* for female American shad derived from the electrofishing survey and commercial harvest were above the threshold in 2004, Estimates remained below the threshold through 2022 as the commercial harvest declined. Due to the lack of survey data for 2020, only two years of the survey index are used in the hind cast 3-year average for the relative *F* estimates from 2020 through 2022.

9.5 Areas Covered by Sustainability Parameters

Monitoring and sustainability parameters in the Neuse River are representative of the entire Neuse River basin, including tributaries. Management measures taken as a result of sustainability plan triggers will be applied at the basin level and will include all tributaries.

9.6 Additional Considerations

Access to American shad spawning habitat is affected by streamflow conditions on the Neuse River, and the variability in timing and strength of streamflow can determine where American shad spawn. The removal of Milburnie Dam (rkm 352) in 2017 opened approximately 25 km of additional spawning habitat to American shad in the mainstem Neuse River. American shad currently have access to more than 90% of the historical habitat extent in the Neuse River (ASMFC 2020). Since the removal of Milburnie Dam, migrating American shad have been documented at the base of Falls Dam (rkm 379) and they no longer congregate at the former dam location (T.D. VanMiddlesworth, NCWRC, personal communication). The lack of migration impediments should benefit the Neuse River American shad population in the future, but further research is needed to determine how habitat selection and spawning success might be related to streamflow. Additionally, changes to survey methods to include upstream habitat need to be evaluated.

As noted in the previous section, an annual creel survey rotation prior to 2012 as well as efforts by NCDMF to expand creel surveys upstream have improved recreational effort and catch/harvest estimates. Annual creel surveys in the Neuse River are anticipated to continue. Expansion of existing surveys to provide accurate JAIs for all commercially and recreationally important species is a NCDMF priority. In 2019, NCDMF expanded the juvenile seine survey (Program 100) to the Tar-Pamlico, Neuse, and Cape Fear river systems. The survey is operated using the same gear and time frame as described in Section 5.1.1 for the Albemarle Sound. While the seine survey was expanded primarily for striped bass, river herring and shad may also be intercepted as the survey is conducted in known anadromous spawning areas. Due to the short time-series, this data was not evaluated for the 2023 SFP but will be evaluated under the next 5-year SFP.

10. CAPE FEAR RIVER

10.1 Stock Status

The overall stock status could not be determined for the Cape Fear River based on the 2020 ASFMC stock assessment (ASMFC 2020). Juvenile mortality status is unknown due to lack of data. Adult mortality status is also unknown, as the delay-difference model experienced diagnostics problems and could not be used for status determination. Abundance status is unknown due to lack of juvenile data. There was an increasing trend in adult abundance since 2005. American shad in the Cape Fear River are semelparous (spawn once followed by death) whereas in the Albemarle Sound system, Tar-Pamlico, and Neuse rivers they are iteroparous (repeat spawners).

10.2 Commercial Fishery

From 1972 through 1993, commercial harvest displayed several cyclical peaks (1972, 1982, and 1993) although each successive peak was slightly lower than the previous. Since 1994, harvest from the Cape Fear River has been lower overall compared to 1972–1993 (Figure 4). Harvest from 1994 to 2018 ranged from 6,804 pounds in 1999 to 46,148 pounds in 2014, with an average of 19,000 pounds harvested per year. Harvest in 2014 was the highest since 1993. The increase for this particular year is attributed to a new market opening and extra effort in this fishery. Since the 2014 peak, effort has been reduced, as participants are aging out of the fishery, and anchored gill nets have been removed from the fishing grounds.

As with the other river systems, most American shad are harvested from gill nets in the Cape Fear River. There has been very little harvest from other gears. Since February 15, 2017, anchored large mesh gill nets (4.0–6.5-inch) are prohibited in the Cape Fear River (north of the Railroad Bridge) and Northeast Cape Fear River (north of I-40 bridge) north of Wilmington, NC. Gear restrictions coupled with lack of participants have contributed to a decline in commercial harvest with less than 10,000 pounds of American shad landed from 2019 through 2022.

10.3 Recreational Fishery

Estimates of angler effort and catch are calculated through creel surveys noted in the fishery-dependent, Section 6.2, of this plan. The 2022 Cape Fear River creel survey determined recreational anglers harvested 2,666 American shad and took 1,258 targeted trips, 0 hickory shad and took 0 targeted trips, and 0 miscellaneous shad and took 0 targeted trips (Table 6). In 2013, the daily creel limit was reduced to a maximum of 5-fish American shad limit within the 10-fish shad aggregate daily limit. It is important to note that hickory shad are encountered infrequently in the Cape Fear River and most of the recreational effort is focused on American shad. Trip and effort estimates for specific shad species is calculated from anglers that indicate target species as American shad, hickory shad, or miscellaneous shad. Catch estimates are based on the shad species caught as indicated by the angler or observed by the creel clerk.

10.4 Sustainability Parameters

The sustainability parameters selected for the Cape Fear River system were the female CPUE index and female relative *F*. Exceeding the threshold in three consecutive years for any of the selected parameters will trigger management action (see Section 14 for additional detail).

Data used in the development of sustainability parameters for the Cape Fear River system include electrofishing data collected by NCWRC (Section 5.1.2.1.2), commercial harvest data collected through the NCTTP (Section 6.1), and recreational harvest data collect through the CSMA Creel Survey (Section 6.2.3). There is no directed long-term juvenile abundance survey for the Cape Fear River system. An IGNS has been conducted consistently in the Cape Fear River since 2007, but these data are not suitable for sustainability parameters due to low catch rates of American shad (Section 5.1.2.3).

10.4.1 Female CPUE (electrofishing survey)

Female CPUE (electrofishing survey): The female CPUE index based on the NCWRC electrofishing survey was calculated as the number of fish per minute using data collected from March through April at Lock and Dam 1 (LD-1) and Lock and Dam 2 (LD-2, Figure 13). Lock and

Dam 3 (LD-3) was removed from analysis due to concerns that sampling in this area could be artificially inflating abundance estimates due to the lack of passage above LD-3. Additionally, sampling from the month of May was removed from analysis due to inconsistent effort across the time series.

- Time series: 2001–2022 (no survey data available for 2020)
- Index Value: annual, ratio estimator
- Threshold: 25th percentile (where 75% of all values are greater) from the fixed time series 2001–2017.
- Trigger: Three consecutive years of values below the threshold.

Electrofishing surveys for American shad were incomplete in 2020 due to limitations resulting from the Covid-19 pandemic and resumed as usual in 2021. The ASWG reviewed the data and recommended retaining the baseline fixed time-series of 2001–2017, established in the 2018 SFP, to determine the threshold value for the sustainability parameter.

Female relative abundance of American shad derived from the electrofishing survey in the Cape Fear River has been variable and remained above the threshold for the past 12 years (2011–2022). The index was below the threshold in 2006, 2008, and 2009.

10.4.2 Female Relative *F* (electrofishing survey)

Female Relative F (electrofishing survey): Female relative *F* (fish) based on the NCWRC electrofishing survey was calculated using the combined commercial and recreational harvest from the Cape Fear River and the female CPUE index from the Cape Fear River electrofishing survey (Table 7, Figure 14). Relative *F* is not available for 2012 due to lack of recreational data.

- Time series: 2011–2022 (no survey data available for 2020)
- Index Value: Calculated by dividing annual combined commercial and recreational harvest (fish) by a hind cast 3-year average of a survey index (current year + previous two years).
- Threshold: 75th percentile (where 25% of all values are greater) from the fixed time series 2011–2022.
- Trigger: Three consecutive years of values above the threshold.

Relative *F* is computed by dividing the combined commercial and recreational harvest (fish) by a hind cast 3-year average of a fishery-independent index (female CPUE, electrofishing survey) as described in Section 8.4.2. To convert commercial harvest to numbers of fish, individual weight data collected from the Cape Fear River commercial fishery (2001–2017) was used to calculate average individual fish weight for female (3.567 lb/roe) and male (2.272 lb/buck). Under the 2023 SFP, female relative *F* estimates were above the threshold in 2011, 2013, and 2014. Since 2015, the index has remained below the threshold. Due to the lack of survey data for 2020, only two years of the survey index are used in the hind cast 3-year average for the relative *F* estimates from 2020 through 2022.

In the 2013 SFP, the female CPUE for the Cape Fear River was truncated to represent the commercial season, March through April (2001–2017). Truncating the female CPUE to the March through April has increased the variability in the point estimates for relative *F* and reduced the sample size. The threshold for this plan was not fixed and changed with a new year of data. In 2017, the terminal year of the 2013 SFP, the female relative *F* index was above the threshold in 2007, 2008, 2009, and 2010.

The 2018 SFP, maintained the female relative *F* calculation based on the truncated female CPUE but fixed the time-series of data used to calculate the threshold to 2003–2017. Estimates of relative *F* for female American shad derived from the electrofishing survey and commercial harvest were above the threshold in 2010. Estimates remained below the threshold through 2022 as the commercial harvest declined. Due to the lack of survey data for 2020, only two years of the survey index are used in the hind cast 3-year average for the relative *F* estimates from 2020 through 2022.

10.5 Areas Covered by Sustainability Parameters

Monitoring and sustainability parameters in the Cape Fear River are representative of the entire Cape Fear River basin and tributaries, including the Black River and the Northeast Cape Fear River. Fishery-independent monitoring is performed in the Cape Fear River mainstem through adult electrofishing and gill net surveys (see Section 5.1.2 for more details). Fishery-dependent monitoring is preformed through NCTTP trip level commercial harvest monitoring and recreational creel sampling. It is important to note that while fishery-independent monitoring outside of the electrofishing survey is not used to calculate sustainability parameters, monitoring of adults and juveniles are occurring in the Cape Fear River mainstem below the lock and dam, in an effort to track trends in abundance. Management measures taken as a result of sustainability plan triggers will be applied at the basin level and will include all of the mainstem Cape Fear River and its tributaries including the Black River and Northeast Cape Fear River.

10.6 Additional Considerations

Collaborative habitat enhancement projects that focus on fish passage and increasing spawning habitat have been implemented on the Cape Fear River in recent years. Each year, NCWRC recommends a locking schedule to the US Army Corps of Engineers to pass anadromous fishes upstream of locks and dams during the spring spawning run. In 2012, a rock arch fishway was constructed below LD-1 to facilitate volitional, upstream fish passage. Telemetry studies conducted to evaluate American shad usage of the rock arch fishway indicate American shad passage efficiency at the LD-1 fishway ranged 53–65% and was consistent with prior estimates from locking procedures (Raabe et al. 2016). Electrofishing surveys corroborate the telemetry studies, as electrofishing catch rates have increased at the upper two locks and dams and decreased at LD-1 over the last five years. These results indicate American shad are readily passing LD-1. With presumed historic spawning grounds, upstream of LD-3, substrate was strategically placed below 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. American shad spawning activity was observed by NCWRC 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 and 2017, NCWRC staff collected eggs at all three locks and dams, with the peak catches below LD-3 (Morgeson and Fisk 2018). Locking at LD-1 has ceased since the construction of the rock-arch fishway but continues for LD-2 and LD-3 to facilitate fish passage. However, the lock structures at LD-2 and LD-3 were damaged by Hurricanes Matthew and Florence and have been inoperable since 2018. Inoperable locks at LD-2 and LD-3 have likely reduced the number of American shad migrating upstream in recent years. 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, and the US Army Corps of Engineers is planning to refurbish the lock chambers to resume fish passage operations in 2023.

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

As noted in the previous section, an annual creel survey rotation prior to 2013 as well as efforts by NCDMF to expand creel surveys upstream have improved recreational effort and catch/harvest estimates. Annual creel surveys in the Cape Fear River are anticipated to continue. Expansion of existing surveys to provide accurate JAIs for all commercially and recreationally important species is a NCDMF priority. In 2019, NCDMF expanded the juvenile seine survey (Program 100) to the Tar-Pamlico, Neuse, and Cape Fear river systems. The survey is operated using the same gear and time frame as described in Section 5.1.1 for the Albemarle Sound. While the seine survey was expanded primarily for striped bass, river herring and shad may also be intercepted as the survey is conducted in known anadromous spawning areas. Due to the short time-series, this data was not evaluated for the 2023 SFP but will be evaluated under the next 5-year SFP.

11. PEE DEE RIVER

The Pee Dee River originates in North Carolina before flowing into South Carolina and emptying into Winyah Bay with approximately 25 km of American shad spawning habitat located in the North Carolina portion of the Pee Dee River. Neither NCWRC nor NCDMF have the resources to conduct monitoring activities in this system. However, South Carolina Department of Natural Resources maintains monitoring programs in the Pee Dee River, which is considered a surrogate monitored system to the Little River. Monitoring programs in place for the Pee Dee River run of American shad are considered by the Shad and River Herring TC and Management Board to be adequate and sustainable at current levels. The approved sustainability target for the Pee Dee River run is 3.41 kilograms of American shad per unit of effort (92 meters of gill net per hour). Should the annual metric of catch per unit effort of American shad fall below the sustainability target for three consecutive years, management responses will be applied. Potential management actions may include gear restrictions, season changes, catch limits, or closure. Additional information on the sustainability target for the Pee Dee River can be found in the South Carolina SFP for American shad.

Additionally, Duke Energy began annual electrofishing surveys in 2016 to monitor the American shad population in the North Carolina section of the Pee Dee River downstream of their hydroelectric facility at Blewett Falls Dam. This survey, along with SCDNR monitoring further downstream, will be used to evaluate trends in American shad and could eventually be used to develop sustainability metrics when the time series reaches appropriate length. Commercial and recreational fisheries were approved in the South Carolina SFP issued in 2012. Commercial harvest of American shad is prohibited in the North Carolina portion of the Pee Dee River, but recreational harvest of 10 American shad per day is allowed under an exception to the statewide recreational creel limit of 1-American shad per day, as amended in 2019. This recreational creel limit is consistent with the creel limit in South Carolina. We propose maintaining the recreational fishery in the North Carolina portion of the Pee Dee River and defer American shad management and determination of sustainability to South Carolina. Should metric benchmarks be triggered in the

Pee Dee River, NCWRC will complement management actions in North Carolina waters to maintain consistency with South Carolina when appropriate.

12. LITTLE RIVER

The Little River is a small coastal river that flows primarily through Little River, South Carolina. The river runs the border between North Carolina and South Carolina, before emptying into the Atlantic Ocean at the Little River Inlet, South Carolina. A large portion of the river forms part of the Atlantic Intracoastal Waterway. American shad may travel to the Waccamaw River (South Carolina) through the Little River, but this is not a known spawning river. Neither NCWRC nor NCDMF have the resources to conduct monitoring activities in this system. However, South Carolina Department of Natural Resources maintains monitoring programs in the Pee Dee River, which is considered a surrogate monitored system to the Little River. Monitoring programs in place for the Pee Dee River run of American shad are considered by the Shad and River Herring TC and Management Board to be adequate and sustainable at current levels. Should sustainability metric benchmarks be triggered in the Pee Dee River as determined by SCDNR, complementary management responses will be applied to the Little River in both North Carolina and South Carolina. Potential management actions may include gear restrictions, season changes, catch limits, or closure. Additional information on the sustainability target for the Pee Dee River can be found in the South Carolina SFP for American shad.

13. OTHER AREAS

The areas included in the sustainability parameters submitted for consideration above contain the known American shad spawning populations in North Carolina, and those systems support the only directed recreational and commercial fisheries in the state. However, American shad are incidentally encountered in commercial fisheries prosecuted within other non-spawning rivers and coastal sounds. Commercial harvest from these areas is a very small proportion of annual American shad harvest (Figure 2) and is primarily considered incidental bycatch. For example, commercial harvest from the New and White Oak rivers (two coastal, blackwater rivers) combined averaged only 140 pounds per year between 1994 and 2016. Recreational effort and harvest in areas outside of spawning rivers is most likely non-existent. In the New and White Oak rivers, recreational creel survey intercepts from 2004 to present have not indicated American or hickory shad as target species and no American or hickory shad have been reported in the catch. While there are currently no independent surveys for American shad outside of spawning rivers, surveys for other species rarely encounter American shad. We propose to maintain current harvest seasons (February 15–April 14) to allow commercial harvest of incidental bycatch because these fish will most likely be dead discards and the amount of harvest is minimal. The areas without specified sustainability parameters will fall under statewide management measures listed in Table 11 and Table 12. North Carolina will continue to monitor commercial landings through the North Carolina Trip Ticket Program to ensure landings remain low. Dedicated monitoring programs or area closures will be implemented if sudden increases in landings, indicating targeted effort, occur.

14. MANAGEMENT MEASURES

14.1 Potential Management Measures

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

- Restrictions on length of season to reduce effort (e.g., March 1–April 14) not to extend beyond the estuarine striped bass quotas being filled (avoids waste of striped bass and shad)
- Trip limits (this may result in discards)
- Reduce allowable number of yards for gill nets
- Area/season closure (e.g., area closure at mouth of Roanoke River from February–mid-November since 1988)
- Only allow fishing certain days of the week (lift days)
- Recreational creel reduction
- Commercial harvest quota (although possible, this could be difficult to implement given existing resources)

Management measures taken under this plan, due to three consecutive years exceeding the sustainability parameter(s) threshold(s) established in Sections 7.4, 8.4, 9.4, and 10.4, shall be retained until the threshold(s) have been met for at least five consecutive years. Following this time period, management measures may be removed as long as the sustainability parameter(s) for the area remain within the respective threshold(s) for three out of the five years.

14.2 Management Measures implemented 2013–2017

Changes in management (season lengths, creel limits) since implementation of the SFP in 2013 have been noted in Section 4 and are summarized for convenience in Table 11 and Table 12. Although harvest is an obvious potential contributor to population declines, significant habitat degradation has also occurred in all the river systems. It is unlikely that American shad populations in North Carolina will recover and expand without considerable resources being dedicated to habitat restoration for this species. Our management goals, however, are intended to sustain population levels as additional habitat is protected or improved through aquatic habitat conservation measures and increased passage opportunities of American shad beyond impediments that block migration to historic spawning grounds.

14.3 Management Measures implemented 2018–2022

No management action was taken under the 2018 SFP as a result of thresholds being exceeded. Management measures for the Albemarle Sound commercial season, implemented in 2014, were retained from 2018 through 2022.

14.4 Cape Fear River

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

Additional analyses (see Appendix 2 of the 2012 SFP) were conducted to determine the commercial and recreational reductions in harvest that would provide an additional conservation buffer. It was determined that equivalent reductions in harvest for both commercial and recreational sectors would provide the greatest benefit given that commercial and recreational harvest in 2011 were roughly equivalent. Management options that resulted in a 25% reduction in harvest for each sector were calculated, and it was determined that a shortened commercial season and a reduction in the recreational creel limit would best meet the required reductions in harvest. While commercial and recreational harvests have fluctuated somewhat since regulatory changes

were implemented, both the electrofishing index and relative *F* index have remained above and below their respective thresholds since 2012. A commercial season from February 20 through April 11 and a recreational creel limit of five fish within the 10-fish aggregate resulted in the necessary 25% reduction.

14.5 Proposed Management Measures for 2023

The following management measures are proposed to be effective January 1, 2023.

14.5.1 Recreational

Statewide Internal Waters including Albemarle Sound-Roanoke River, Neuse River, except as exempted below

- It is unlawful to possess more than ten (10) American shad or hickory shad in the aggregate, per person per day taken by hook-and-line or for recreational purposes and only one (1) of the ten (10) may be an American shad.

Tar-Pamlico River, Pee Dee River

- It is unlawful to possess more than ten (10) American shad or hickory shad, in the aggregate, per person per day taken by hook-and-line or for recreational purposes.

Cape Fear River

- It is unlawful to possess more than ten (10) American shad or hickory shad in the aggregate, per person per day taken by hook-and-line or for recreational purposes and only five (5) of the ten (10) may be an American shad.

14.5.2 Commercial

Albemarle Sound Coastal and Joint Fishing Waters

- For 2023, a commercial season of February 15–April 14 has been established based on sustainability parameters for this system.
- The commercial season may occur anytime between January 1–April 14 for the 5-year tenure of this plan.

Tar-Pamlico River, Neuse River Coastal and Joint Fishing Waters

- For 2023, a commercial season of February 15–April 14 has been established based on sustainability parameters for this system.
- The commercial season may occur anytime between February 15–April 14 for the 5-year tenure of this plan.

Cape Fear River Coastal and Joint Fishing Waters

- For 2023, a commercial season of February 20–April 11 has been established based on sustainability parameters for this system.
- The commercial season may occur anytime between February 20–April 11 for the 5-year tenure of this plan.

All Other Internal Coastal and Joint Fishing Waters

- For 2023, a commercial season of February 15–April 14 has been established based on the Tar-Pamlico River, Neuse River, and Cape Fear River sustainability parameters.
- The commercial season may occur anytime between February 15–April 14 for the 5-year tenure of this plan.

While none of the selected sustainability parameters for any of the river systems have exceeded the triggers for management since 2013, the above measures are considered prudent given the results of the 2020 stock assessment as they pertain to North Carolina. The Albemarle Sound is the only system in North Carolina where abundance status, relative to historic levels, was determined to be not depleted. The overall status for the other areas remains unknown, in large part due to a lack of juvenile data. The Albemarle Sound adult total mortality rate was determined sustainable, and abundance determined to be not overfished. Additionally, the Albemarle Sound juvenile abundance demonstrated an increasing trend from 2005–2017, the selected time period for abundance trends (ASMFC 2020). Given the Albemarle Sound status determination and the management measures in place for striped bass conservation also benefiting American shad (Section 4.2.1), the ASWG elected to expand the potential time frame in which the Albemarle Sound commercial fishery can occur from March 3–24 to January 1–April 14. The expanded time frame allows for flexibility in management to ensure that the fishery remains sustainable while maximizing the opportunity to stakeholders impacted by management restrictions for striped bass in this area. Commercial seasons, for all areas, will be determined after NCDMF and NCWRC jointly review the performance of the plan, annually, to determine management measures for the following season. Future changes to creel limits for American shad in the Inland Fishing Waters of the other river systems will also be complemented by NCDMF for Joint and Coastal Fishing Waters.

15. ANCILLARY INFORMATION AND FUTURE CONSIDERATIONS

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

The use of repeat spawning data was also considered as a potential sustainability parameter and continues to be tracked annually as part of the required monitoring program. Repeat spawning could be used as ancillary information for determining future management but would lag a year behind (current years index values) due to the time required for processing and ageing of scales. Outside of the Albemarle Sound, limited repeat spawning information is available due to decline in commercial fisheries, lack of positive intercepts in NCDMF surveys, and NCWRC use of otoliths for ageing. Additionally, inconsistencies in determination of repeat spawning marks exist coastwide. Therefore, the use of repeat spawning data for sustainability parameter thresholds may be difficult. Should greater confidence in repeat spawning data be attained in the future, they may be considered for developing a formal sustainability parameter.

The ASWG will continue to review the performance of the plan on an annual basis (fall/winter of current fishing year) to determine management measures for the following season. Sustainability parameters will continue to be updated annually in compliance reports, detailing the performance of the plan and implementation of management measures, where necessary.

If appropriate, North Carolina will submit a revised SFP for TC review to allow for inclusions or modifications described above.

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TABLES

Table 1. North Carolina Sustainable Fishery Plan for American shad summary of management thresholds and triggers for 2023–2027.

System	Index	Threshold Value	Threshold Time Series	Threshold Level	Management Trigger
Albemarle Sound-Roanoke River	Albemarle Sound Juvenile CPUE	0.3849	1996-2021	25th percentile	3 consecutive years below the threshold
Albemarle Sound-Roanoke River	Roanoke River Female CPUE	0.1314	2001-2017	25th percentile	3 consecutive years below the threshold; does not trigger management by itself
Albemarle Sound-Roanoke River	Albemarle Sound Female CPUE	0.0388	2000-2017	25th percentile	3 consecutive years below the threshold
Albemarle Sound-Roanoke River	Female Relative *F*	2,649,747 (lb)	2002-2017	75th percentile	3 consecutive years above the threshold
Tar-Pamlico River	Female CPUE	0.3843	2000-2017	25th percentile	3 consecutive years below the threshold
Tar-Pamlico River	Relative *F*	4,009 (fish)	2012-2022	75th percentile	3 consecutive years above the threshold
Neuse River	Female CPUE	0.1275	2000-2017	25th percentile	3 consecutive years below the threshold
Neuse River	Relative *F*	10,631 (fish)	2012-2022	75th percentile	3 consecutive years above the threshold
Cape Fear River	Female CPUE	0.1161	2001-2017	25th percentile	3 consecutive years below the threshold
Cape Fear River	Relative *F*	44,147 (fish)	2011-2022	75th percentile	3 consecutive years above the threshold

Table 2. Tar-Pamlico River recreational creel survey estimates for trips targeting Shad species (including hickory and American shad) in numbers and pounds of fish, 2012–2022.

		Effort				Catch					
		Trips	PSE	Hours	PSE	Harvest	PSE	Weight (kg)	PSE	Discard	PSE
American	2012	595	44.7	1,495	50.1	899	42.7	776	42.0	4,257	33.7
	2013	105	76.2	122	82.9	2,479	21.1	3,098	24.1	7,053	41.4
	2014	0	0.0	0	0.0	168	65.2	206	65.2	1,314	74.0
	2015	54	100.0	54	100.0	1,006	47.7	1,480	47.7	2,784	78.7
	2016	1,345	31.2	5,798	51.5	1,051	50.1	1,546	50.1	2,820	34.0
	2017	282	84.9	663	97.4	898	68.9	979	68.9	2,217	43.4
	2018	2,502	18.7	5,635	22.1	685	62.2	720	62.3	2,767	42.1
	2019	11	100.0	31	100.0	544	60.7	428	60.7	3,028	47.7
	2020	0	0.0	0	0.0	209	79.5	164	79.5	562	39.8
	2021	860	24.8	3,903	48.4	731	40.8	882	40.8	4,236	43.1
	2022	201	76.0	591	96.2	464	68.0	549	68.0	995	55.2
Hickory	2012	460	58.0	646	52.3	403	59.8	0	0.0	7,384	36.7
	2013	0	0.0	0	0.0	2,247	58.3	1,345	58.4	5,489	55.3
	2014	139	65.0	177	74.5	341	70.1	202	70.1	2,052	56.6
	2015	207	62.0	597	62.0	864	62.0	458	62.8	3,848	53.4
	2016	318	52.3	2,109	68.3	1,409	70.9	718	70.9	11,590	67.2
	2017	0	0.0	0	0.0	1,695	47.1	890	46.7	7,105	49.8
	2018	2,021	32.6	5,396	38.4	925	45.1	521	45.5	6,065	41.3
	2019	58	58.6	268	79.8	4,068	40.1	2,251	40.5	8,502	47.0
	2020	0	0.0	0	0.0	738	54.5	522	53.5	9,058	61.1
	2021	351	45.9	2,125	86.5	5,374	51.7	2,756	51.9	13,896	49.7
	2022	0	0.0	0	0.0	806	44.5	528	43.5	997	42.8
Misc Shad	2012	4,736	19.8	13,251	28.1	88	100.0	0	0.0	420	67.5
	2013	7,309	18.0	16,445	19.9	234	100.0	0	0.0	6,079	34.0
	2014	2,472	22.7	6,855	30.8	0	0.0	0	0.0	38	71.0
	2015	3,521	24.9	9,200	34.5	0	0.0	0	0.0	2,105	88.2
	2016	3,574	26.6	10,216	38.7	0	0.0	0	0.0	0	0.0
	2017	5,893	21.0	16,375	28.7	0	0.0	0	0.0	405	91.5
	2018	1,173	32.8	1,872	47.2	0	0.0	0	0.0	237	69.1
	2019	5,662	18.9	12,925	18.9	180	100.0	0	0.0	1,995	61.2
	2020	5,913	46.8	20,171	49.8	0	0.0	0	0.0	7,016	40.5
	2021	9,035	21.3	17,401	28.9	884	70.6	0	0.0	11,693	49.5
	2022	5,444	27.6	7,632	23.0	111	77.5	0	0.0	3,420	33.3

Table 3. Tar-Pamlico River sustainability parameter for female relative *F* (fish) based on the female CPUE index (FI-NCWRC electrofishing survey) and the combined commercial and recreational harvest from the Tar-Pamlico River, 2010–2022. Recreational data for 2010–2011 and FI-NCWRC Survey for 2020 are not available.

	Recreational	Commercial		Rec+Comm	FI-NCWRC Survey Index (num/min), female only						Relative *F* Hind 3-yr Avg.	Threshold 75th Percentile
Year	Rec (num fish)	Total (lb)	Comm (num fish)	Total (num)	Index	SD	SE	PSE	Fish (num)	Effort	Female (lb)	Female (lb)
2010					0.3828	0.1381	0.0522	13.6	64	167.2		
2011					0.4421	0.2185	0.0892	20.2	63	142.5		
2012	899	6,430	3,101	4,000	0.5200	0.0962	0.0430	8.3	76	146.2	8,923	4,009
2013	2479	7,819.5	2,644	5,123	0.5012	0.1478	0.0467	9.3	129	257.4	10,504	4,009
2014	168	5,176.5	2,026	2,194	0.8200	0.2768	0.1046	12.8	164	200.0	3,575	4,009
2015	1,006	3,173	927	1,933	0.3889	0.1080	0.0382	9.8	105	270.0	3,391	4,009
2016	1,051	742	208	1,259	0.5875	0.1653	0.0585	10.0	141	240.0	2,102	4,009
2017	898	3,565	1,193	2,091	0.4357	0.0702	0.0212	4.9	122	280.0	4,443	4,009
2018	685	1,170	397	1,082	0.2782	0.0791	0.0212	7.6	153	550.0	2,495	4,009
2019	544	0	0	544	0.3533	0.1181	0.0394	11.1	106	300.0	1,529	4,009
2020	209	129	35	244							773	4,009
2021	731	135	16	747	0.7493	0.2424	0.0767	10.2	281	375.0	1,355	4,009
2022	464	463	151	615	0.4145	0.0844	0.0244	5.9	143	345.0	1,056	4,009

Table 4. Neuse River recreational creel survey estimates for trips targeting Shad species (including hickory and American shad) in numbers and pounds of fish, 2012–2022.

		Effort				Catch					
		Trips	PSE	Hours	PSE	Harvest	PSE	Weight (kg)	PSE	Discard	PSE
American	2012	8,315	34.1	17,559	28.7	968	37.5	1,033	37.5	511	46.3
	2013	394	28.0	869	27.0	1,388	47.1	1,325	47.1	2,699	62.2
	2014	426	70.1	1,181	82.1	413	51.2	450	51.2	995	60.3
	2015	214	43.1	683	42.0	94	76.1	133	76.1	132	47.4
	2016	451	28.8	1,481	33.6	252	47.3	193	47.3	1,389	60.6
	2017	389	40.3	783	49.6	518	33.6	602	33.6	2,828	36.5
	2018	43	77.2	35	86.7	112	50.9	130	50.9	356	41.8
	2019	0	0.0	0	0.0	215	57.9	206	57.9	91	70.8
	2020	0	0.0	0	0.0	830	64.8	803	64.8	1,933	66.4
	2021	0	0.0	0	0.0	36	57.9	34	57.9	53	61.6
	2022	22	54.6	92	67.5	36	35.9	56	35.9	170	42.8
Hickory	2012	11,643	28.2	23,148	26.0	10,720	27.9	5,803	28.0	29,038	41.1
	2013	589	40.6	1,564	43.7	12,916	28.3	5,913	26.3	14,286	29.4
	2014	193	67.3	934	61.8	15,278	46.0	7,684	49.6	27,916	39.1
	2015	170	64.2	807	60.9	10,418	35.4	4,621	36.5	12,186	44.0
	2016	225	68.7	415	78.4	10,850	33.1	5,078	36.1	29,225	58.1
	2017	1,359	36.3	7,454	54.5	16,768	26.3	9,158	26.8	69,818	38.0
	2018	260	59.8	822	80.0	17,270	33.0	10,210	35.4	57,497	25.5
	2019	187	86.3	632	84.6	4,107	15.6	2,447	27.5	9,741	23.4
	2020	427	60.9	1,910	56.7	14,133	29.2	8,849	29.5	37,090	28.4
	2021	211	60.6	330	87.1	7,489	30.7	3,963	30.9	19,627	31.8
	2022	65	51.6	238	55.7	4,033	27.1	2,905	30.0	12,800	45.5
Misc Shad	2012	6,620	31.3	14,644	40.2	245	100.0	0	0.0	2,309	97.0
	2013	14,911	14.9	31,332	19.1	0	0.0	0	0.0	798	58.2
	2014	13,117	19.1	31,415	26.1	0	0.0	0	0.0	136	100.0
	2015	7,633	20.3	18,789	26.8	0	0.0	0	0.0	136	75.3
	2016	8,914	18.0	25,316	28.0	0	0.0	0	0.0	898	61.8
	2017	11,318	17.6	41,837	21.5	0	0.0	0	0.0	3,334	71.4
	2018	13,050	17.9	39,956	23.8	0	0.0	0	0.0	448	59.5
	2019	7,531	14.7	22,459	16.9	11	100.0	0	0.0	706	41.4
	2020	10,068	19.6	36,941	24.7	0	0.0	0	0.0	16,017	43.3
	2021	6,370	15.3	19,002	20.9	0	0.0	0	0.0	780	81.1
	2022	6,129	17.5	17,352	25.9	0	0.0	0	0.0	561	50.2

Table 5. Neuse River sustainability parameter for female relative *F* (fish) based on the female CPUE index (NCWRC electrofishing survey) and the combined commercial and recreational harvest from the Tar-Pamlico River, 2010–2022. Recreational data for 2010–2011 and FI-NCWRC Survey for 2020 are not available.

	Recreational	Commercial			FI-WRC Survey Index (num/min), female only						Relative *F* Hind 3-yr Avg.	Threshold 75th Percentile
Year	Total (num fish)	Total (lb)	Total (num)	Rec+Comm (num)	Index	SD	SE	PSE	Fish (num)	Effort	Female (lb)	Female (lb)
2010					0.1087	0.0213	0.0040	3.6	122	1122.6		
2011					0.1460	0.0187	0.0038	2.6	143	979.2		
2012	968	9,222	6,506	7,474	0.2126	0.0383	0.0067	3.1	239	1124.2	47,979	10,631
2013	1,388	12,938	4,871	6,259	0.3104	0.0338	0.0061	2.0	377	1214.6	28,065	10,631
2014	413	2,339	2,819	3,232	0.2578	0.0390	0.0064	2.5	329	1276.1	12,417	10,631
2015	94	2,319	876	970	0.2362	0.0382	0.0064	2.7	157	664.7	3,616	10,631
2016	252	1,997	741	993	0.5181	0.0624	0.0106	2.0	319	615.7	2,944	10,631
2017	518	8,590	3,252	3,770	0.5245	0.0805	0.0140	2.7	361	688.2	8,845	10,631
2018	112	1,684	1,174	1,286	0.2276	0.0271	0.0041	1.8	203	891.9	3,036	10,631
2019	215	1,531	0	215	0.2000	0.0253	0.0039	2.0	157	785.0	677	10,631
2020	830	34	40	870							4,068	10,631
2021	36	10	4	40	0.2213	0.0497	0.0082	3.7	174	786.0	192	10,631
2022	36	228	72	108	0.1003	0.0210	0.0035	3.5	83	827.2	670	10,631

Table 6. Cape Fear River recreational creel survey estimates for trips targeting Shad species (including hickory and American shad) in numbers and pounds of fish, 2011–2016. Creel survey estimates for 2011 from NCWRC alternating CSMA Creel Survey. Survey did not occur in 2012.

Cape Fear River		Effort				Catch					
		Trips	PSE	Hours	PSE	Harvest	PSE	Weight (kg)	PSE	Discard	PSE
American	2011	5,951	11.7	25,706	15.9	14,888	14.2	9,346	13.6	7,425	14.9
	2012										
	2013	0	0.0	0	0.0	18,484	21.1	19,310	20.0	6,154	73.7
	2014	114	84.5	188	88.0	7,256	25.1	10,471	25.4	0	0.0
	2015	0	0.0	0	0.0	4,136	32.7	5,218	32.2	6,125	39.3
	2016	4,525	15.0	18,754	22.5	10,244	22.1	12,879	22.8	10,740	28.6
	2017	1,368	25.0	5,965	28.5	1,352	36.0	1,718	38.5	2,669	75.8
	2018	292	34.2	1,105	38.3	5,384	45.9	5,937	46.6	3,992	44.3
	2019	47	68.7	132	64.6	2,266	39.6	2,624	42.1	1,101	89.4
	2020	1,050	71.3	4,453	74.6	3,582	74.3	3,468	72.1	3,740	81.7
	2021	1,484	24.1	7,325	33.2	2,624	32.0	3,004	31.6	6,914	28.6
	2022	1,258	56.7	3,998	39.9	2,666	79.6	2,768	80.2	953	32.3
Hickory	2011										
	2012										
	2013	0	0.0	0	0.0	13	100.0	0	0.0	152	100.0
	2014	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	2015	0	0.0	0	0.0	12	100.0	0	0.0	0	0.0
	2016	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	2017	0	0.0	0	0.0	14	100.0	0	0.0	0	0.0
	2018	0	0.0	0	0.0	12	100.0	6	100.0	47	100.0
	2019	0	0.0	0	0.0	0	0.0	0	0.0	20	100.0
	2020	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	2021	0	0.0	0	0.0	12	100.0	0	0.0	0	0.0
	2022	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Misc Shad	2011										
	2012										
	2013	12,765	25.2	57,081	25.0	2,036	44.1	1,816	44.1	28,768	40.9
	2014	2,896	18.2	12,253	22.7	196	84.1	175	84.1	11,024	58.7
	2015	3,414	22.2	13,933	26.3	0	0.0	0	0.0	264	71.7
	2016	525	68.2	3,753	71.0	0	0.0	0	0.0	648	79.7
	2017	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	2018	2,325	36.4	10,456	43.7	0	0.0	0	0.0	3,949	86.4
	2019	952	26.4	2,823	27.6	6	100.0	0	0.0	2,307	47.5
	2020	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	2021	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	2022	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

Table 7. Cape Fear River sustainability parameter for female relative *F* (fish) based on the female CPUE index (NCWRC electrofishing survey) and the combined commercial and recreational harvest from the Tar-Pamlico River, 2009–2022. Recreational data for 2009–2010, 2012 and FI-NCWRC Survey for 2020 are not available.

	Recreational	Commercial		Rec+Comm	FI-WRC Survey Index (num/min), female only						Relative *F* Hind 3-yr Avg.	Threshold 75th Percentile
Year	Total (num fish)	Total (lb)	Total (num)	Rec+Comm (num)	Index	SD	SE	PSE	Fish (num)	Effort	Female (num)	Female (num)
2009					0.1052	0.0392	0.0138	13.2	31	294.6		
2010					0.1139	0.0375	0.0108	9.5	41	360.0		
2011	14,888	22,446	6,849	21,737	0.1161	0.0321	0.0080	6.9	54	465.0	194,523	44,147
2012		10,225	3,177	3,177	0.1818	0.0490	0.0219	10.0	60	330.0		44,147
2013	18,484	24,888	7,353	25,837	0.2476	0.0452	0.0160	6.7	104	420.0	142,076	44,147
2014	7,256	46,148	13,674	20,930	0.5623	0.1236	0.0343	7.8	295	524.7	63,315	44,147
2015	4,136	25,039	7,354	11,490	0.5701	0.1075	0.0340	5.9	240	421.0	24,978	44,147
2016	10,244	12,937	3,779	14,023	0.5710	0.0494	0.0149	8.5	210	367.8	24,697	44,147
2017	1,352	11,049	3,339	4,691	0.4343	0.0533	0.0154	9.8	237	545.8	8,933	44,147
2018	5,384	14,931	4,329	9,713	0.3230	0.0779	0.0235	7.4	98	303.4	21,938	44,147
2019	2,266	5,076	0	2,266	0.3931	0.0608	0.0203	5.7	96	244.2	5,909	44,147
2020	3,582	6,038	1,932	5,514							15,399	44,147
2021	2,624	4838	1,430	4,054	0.2240	0.0430	0.0136	10.0	103	459.8	13,138	44,147
2022	2,666	2,899	853	3,519	0.2874	0.0320	0.0101	9.5	158	549.8	13,762	44,147

Table 8. American shad fry stocked into the Roanoke River Basin from 1998–2018. Fry were not stocked in years after 2018. Stockings downstream of the lower-most dam occur at Weldon, NC, stockings upstream of John H. Kerr Dam occur at either Altavista or Clover Landing, VA, stockings upstream of Gaston Dam occur at Bracey, VA, and stockings upstream of Roanoke Rapids Dam occur at Roanoke Rapids, NC. Hatchery evaluation techniques have transitioned from Oxytetracyclene (OTC) marks to parentage-based tagging methods using genetic microsatellite markers.

		Fry Totals (millions) by Stocking Location					
Year	Total Fry Stocked (millions)	Weldon, NC	Altavista, VA	Clover Landing, VA	Bracey, VA	Roanoke Rapids, NC	Hatchery Evaluation Technique
1998	0.5	0.5	-	-	-	-	OTC
1999	0.3	0.3	-	-	-	-	OTC
2000	0.8	0.8	-	-	-	-	OTC
2001	2.1	2.1	-	-	-	-	OTC
2002	0.8	0.8	-	-	-	-	OTC
2003	2.3	1.2	1.1	-	-	-	OTC
2004	2.3	1.2	1.1	-	-	-	OTC
2005	2.5	1.3	1.2	-	-	-	OTC
2006	2.4	1.4	1.0	-	-	-	OTC
2007	4.3	2.2	2.1	-	-	-	OTC
2008	8.2	4.3	3.9	-	-	-	OTC
2009	8.6	4.5	4.1	-	-	-	OTC
2010	7.8	6.9	0.9	-	-	-	OTC/PBT
2011	4.4	4.0	-	0.4	-	-	OTC/PBT
2012	4.8	3.8	-	1.0	-	-	OTC/PBT
2013	4.5	2.4	-	1.3	0.8	-	PBT
2014	7.5	3.5	-	1.4	2.6	-	PBT
2015	4.8	2.6	-	0.8	1.5	-	PBT
2016	3.8	1.3	-	-	-	2.5	PBT
2017	2.7	0.3	-	-	-	2.5	PBT
2018	2.3	0.3	-	-	-	2.0	PBT
Total	77.7	45.6	15.4	4.9	4.9	7.0	

Table 9. American shad fry stocked into the Neuse River Basin at NC Highway 117 bridge near Goldsboro and juvenile hatchery contribution based on parentage-based tagging analysis, 2012–2018. Fry were not stocked in years after 2018.

Year	Fry Stocked	Out-migrating Juvenile Hatchery Contribution
2012	573,582	2%
2013	1,184,303	6%
2014	1,377,375	13%
2015	708,045	1%
2016	609,720	0%*
2017	440,161	-
2018	669,902	-
Total	5,563,088	

*Sample size was only 7 fish

Table 10. American shad movement study results in numbers of fish tagged in the Albemarle Sound and numbers of tagged fish detected on spawning runs in the Roanoke and Chowan River from 2013–2019. *In 2014, a single fish tagged in 2013 returned.

			Spawning Run	
Year	Tagged	Detected	Roanoke	Chowan
2013	7	4		1
2014	53	41	2	8*
2016	55	43		2
2017	74	57	3	23
2018	46	40		12
2019	31	27		10
Total	266	212	5	56

Table 11. Commercial harvest seasons for American shad 2012–2022.

Year	Albemarle Sound-Roanoke River	Tar-Pamlico River	Neuse River	Cape Fear River	All Other Areas
*2012	2/1 - 4/14	2/1 - 4/14	2/1 - 4/14	2/1 – 4/14	2/1 – 4/14
2013	2/15 – 4/14	2/15 – 4/14	2/15 – 4/14	2/20 – 4/11	2/15 – 4/14
2014	3/3 – 3/24	2/15 – 4/14	2/15 – 4/14	2/20 – 4/11	2/15 – 4/14
2015	3/3 – 3/24	2/15 – 4/14	2/15 – 4/14	2/20 – 4/11	2/15 – 4/14
2016	3/3 – 3/24	2/15 – 4/14	2/15 – 4/14	2/20 – 4/11	2/15 – 4/14
2017	3/3 – 3/24	2/15 – 4/14	2/15 – 4/14	2/20 – 4/11	2/15 – 4/14
2018	3/3 – 3/24	2/15 – 4/14	2/15 – 4/14	2/20 – 4/11	2/15 – 4/14
2019	3/3 – 3/24	2/15 – 4/14	2/15 – 4/14	2/20 – 4/11	2/15 – 4/14
2020	3/3 – 3/24	2/15 – 4/14	2/15 – 4/14	2/20 – 4/11	2/15 – 4/14
2021	3/3 – 3/17	2/15 – 4/14	2/15 – 4/14	2/20 – 4/11	2/15 – 4/14
2022	3/3 – 3/15	2/15 – 4/14	2/15 – 4/14	2/21 – 4/12	2/15 – 4/14

*last year prior to SFP implementation

Table 12. Recreational creel restrictions for American shad 2012–2022. All numbers represent limits within an overall 10-fish aggregate creel limit for American and hickory shad combined.

Year	Albemarle Sound (AS) Roanoke River (RR)	Tar-Pamlico	Neuse	Cape Fear	Statewide
2012*	AS – 10 fish RR – 1 fish	10 fish	1 fish IW 10 fish CJW	10 fish	10 fish
2013	AS-10-fish IW AS-1-fish CJW RR-1-fish	10 fish	1 fish	5 fish	10 fish
2014	AS-10-fish IW AS-1-fish CJW RR-1-fish	10 fish	1 fish	5 fish	10 fish
2015	AS-10-fish IW AS-1-fish CJW RR-1-fish	10 fish	1 fish	5 fish	10 fish
2016	AS-10-fish IW AS-1-fish CJW RR-1-fish	10 fish	1 fish	5 fish	10 fish
2017	**AS-10-fish IW AS-1-fish CJW RR-1-fish	10 fish	1 fish	5 fish	10 fish
2018	**AS-10-fish IW AS-1-fish CJW RR-1-fish	10 fish	1 fish	5 fish	10 fish
2019	**AS-10-fish IW AS-1-fish CJW RR-1-fish	10 fish	1 fish	5 fish	10 fish 1 fish IW
2020	AS-1-fish RR-1-fish	10 fish	1 fish	5 fish	10 fish 1 fish IW
2021	AS-1-fish RR-1-fish	10 fish	1 fish	5 fish	10 fish 1 fish IW
2022	AS-1-fish RR-1-fish	10 fish	1 fish	5 fish	10 fish 1 fish IW

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

** All Inland Fishing Waters of the Albemarle Sound drainage except the Roanoke River remained under the statewide rule of 10 American shad and hickory shad in the aggregate until the statewide rule for Inland Fishing Waters was changed by NCWRC to one American shad per day on August 1, 2019.

FIGURES

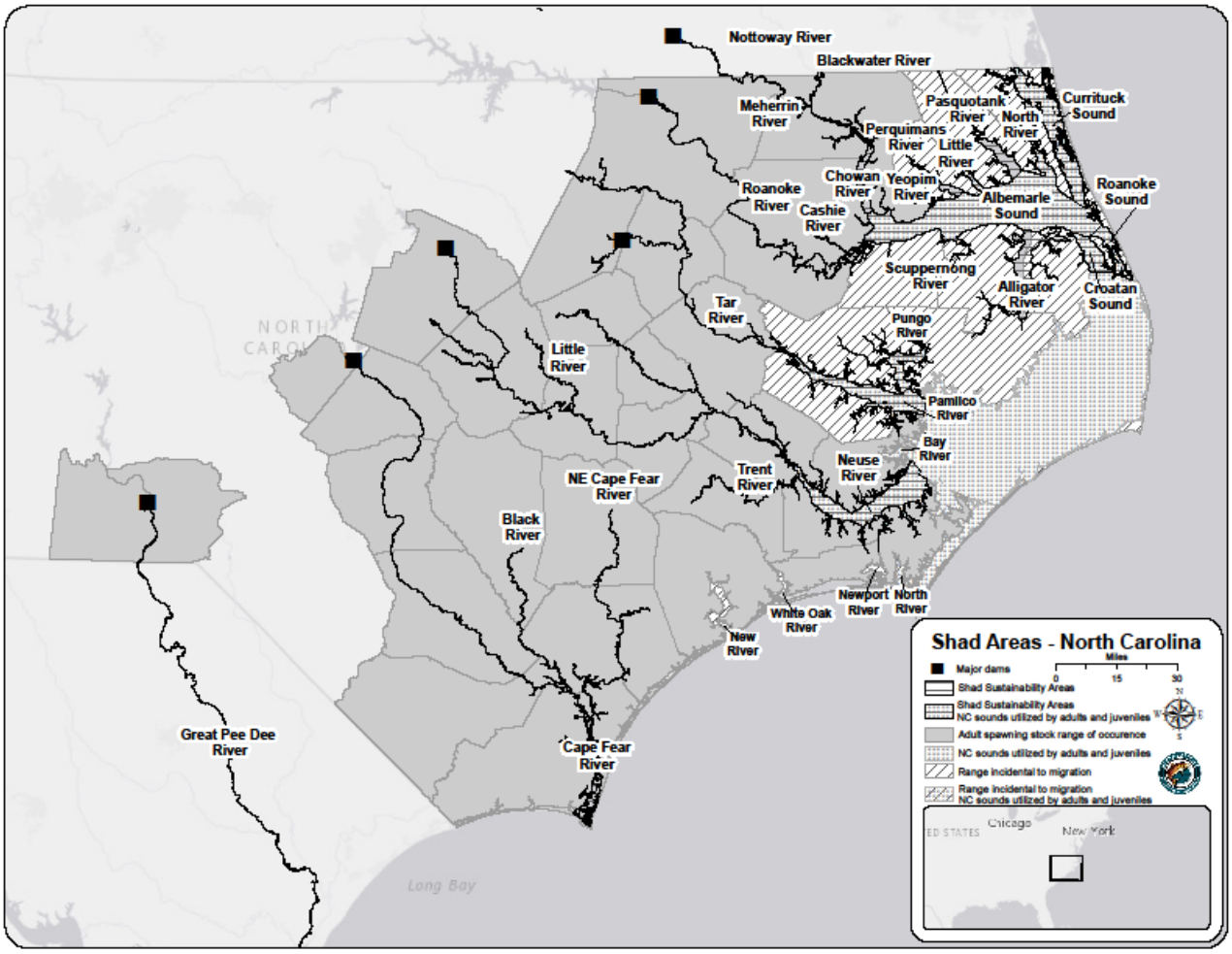


Figure 1. North Carolina river systems depicting the extent of American shad occurrence and habitat use.

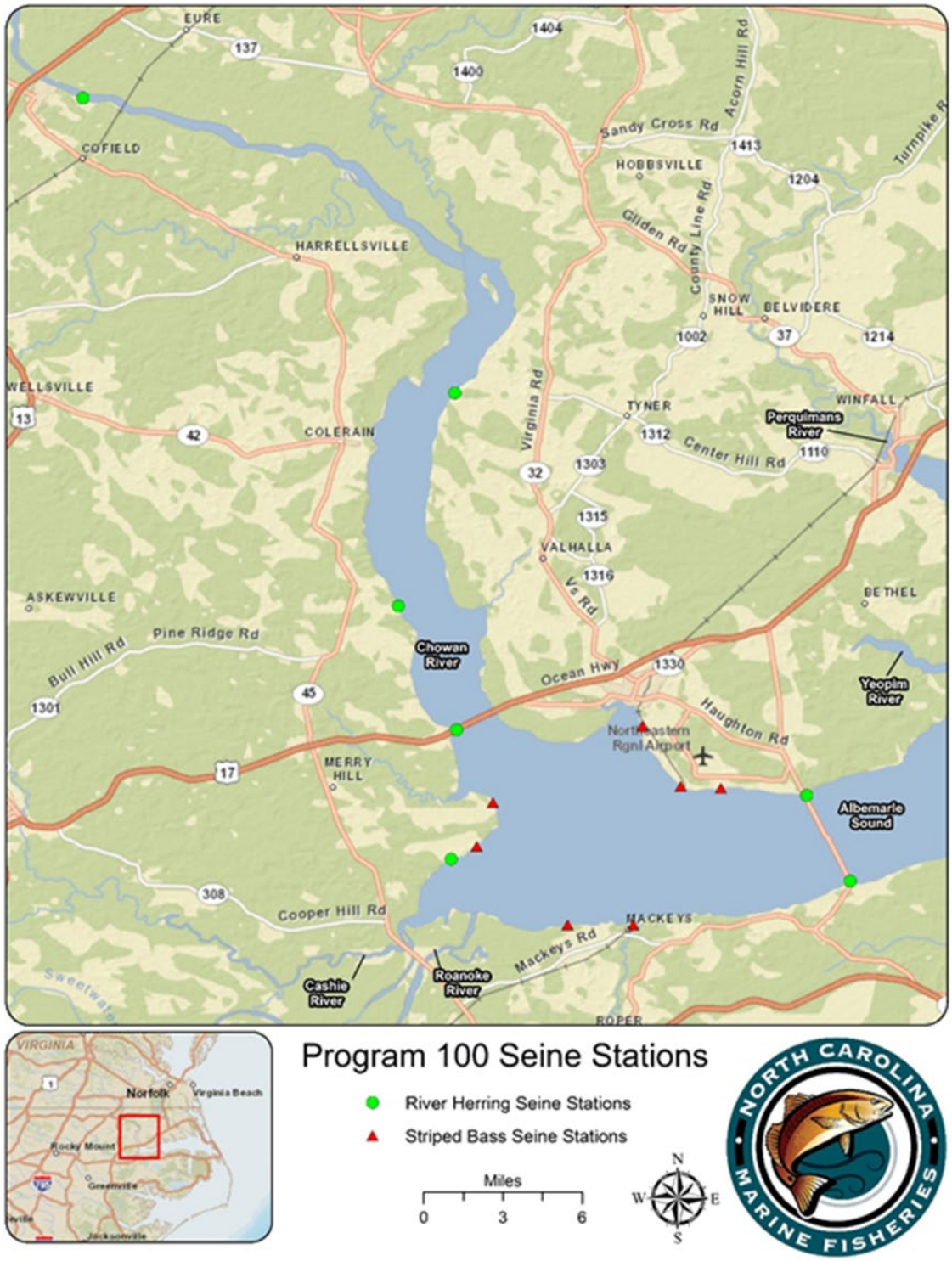


Figure 2. American shad juvenile seine survey sampling sites in the Albemarle Sound Area, 1996-2022.

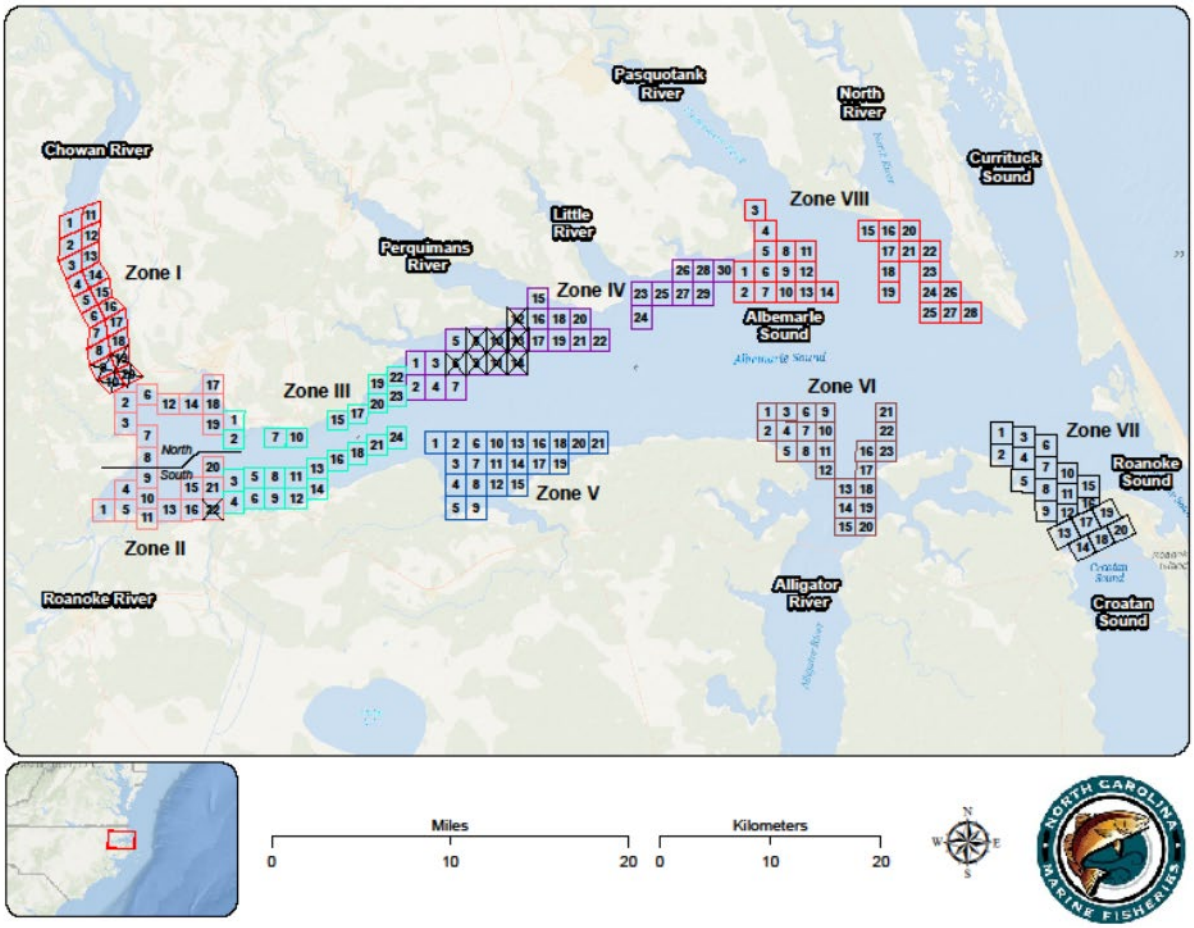


Figure 3. Albemarle Sound Independent Gill Net Survey sampling area. Zones I and VIII added in November 2021.

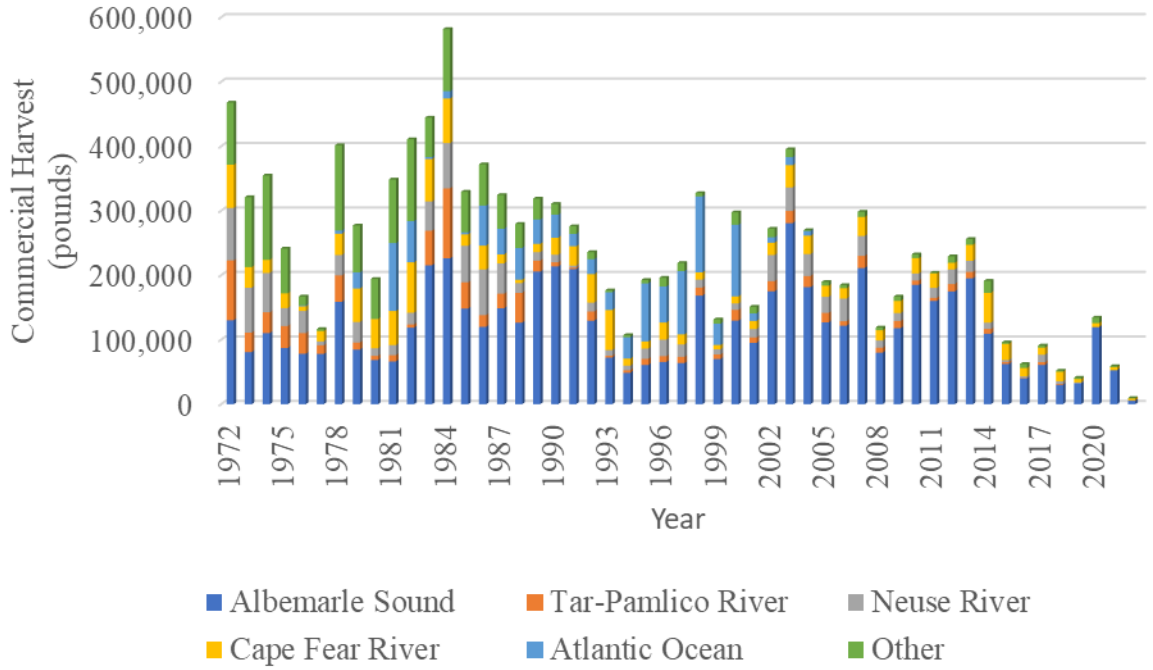


Figure 4. Commercial harvest of American shad from North Carolina by water body, 1972–2022.

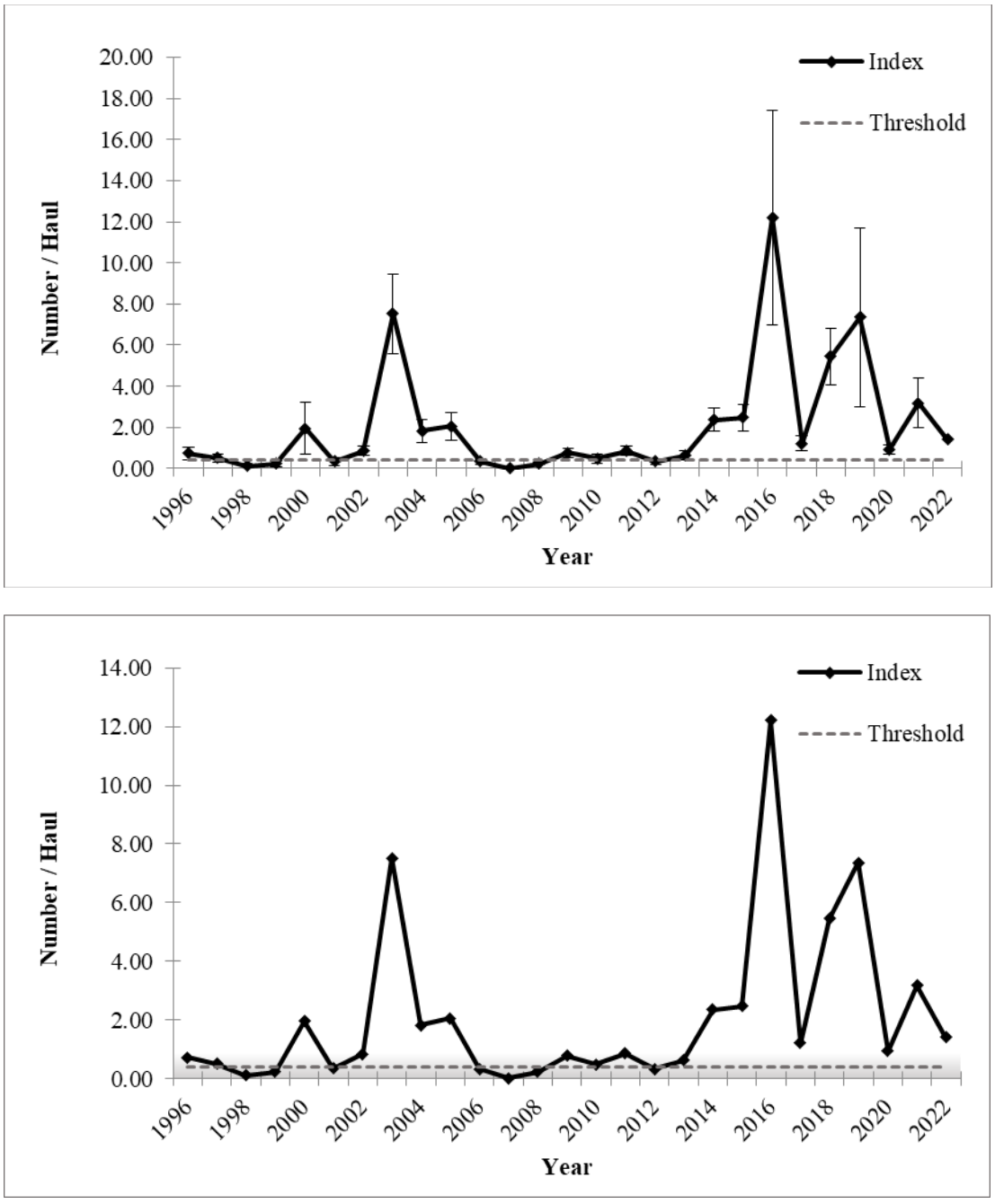


Figure 5. Juvenile abundance index from the NCDMF juvenile seine survey (Jun–Oct) for the Albemarle Sound, 1996-2022. Threshold represents 25th percentile (where 75% of all values are greater). Error bars represent ±1 standard error (top graph). Index value for 2022 is preliminary, error bars not calculated. Values in gray are below the threshold (bottom graph).

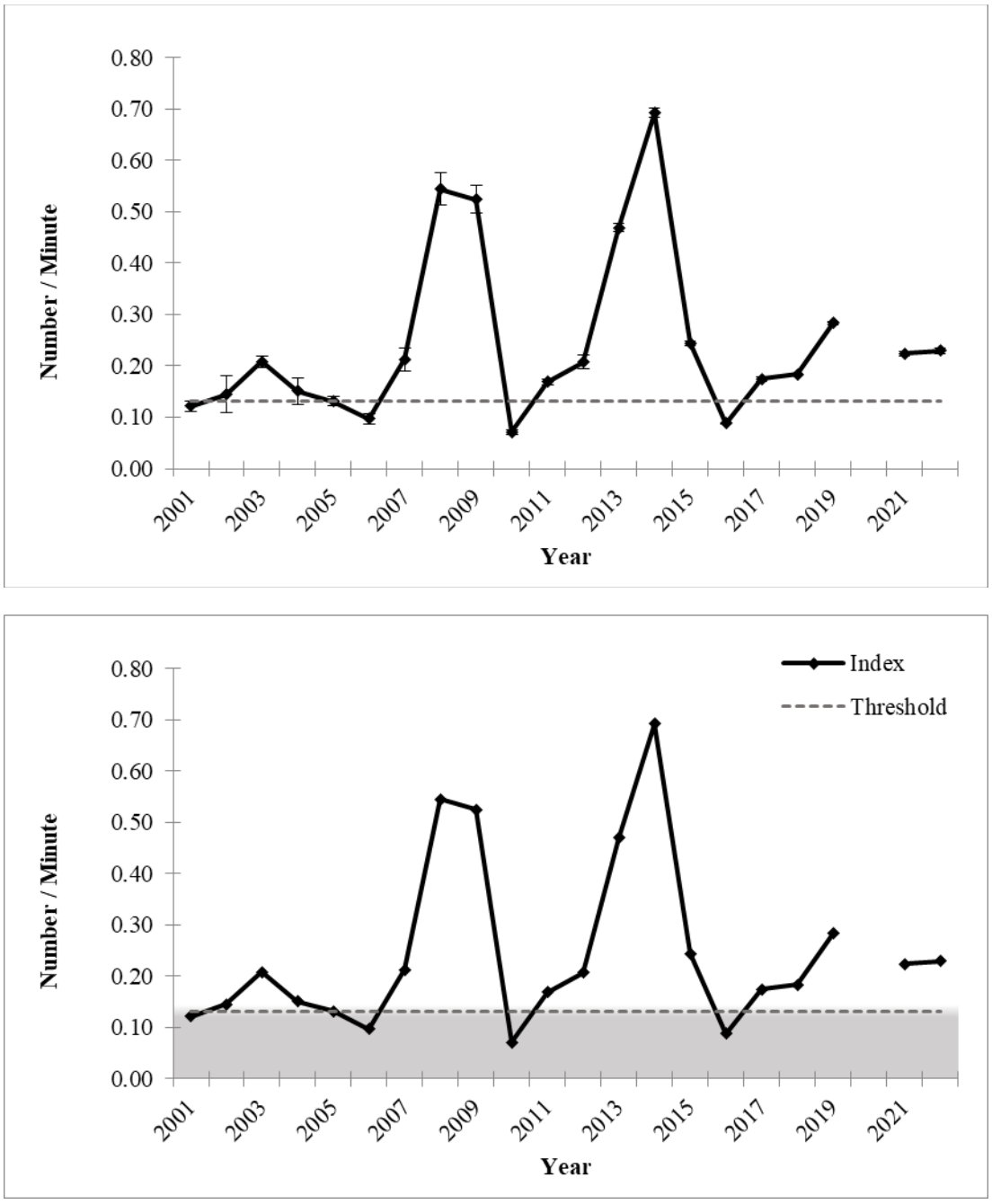


Figure 6. Female index from NCWRC electrofishing survey (March–May) for Roanoke River, 2001-2022. Threshold represents 25th percentile (where 75% of all values are greater). Error bars represent ±1 standard error (top graph). Values in gray are below the threshold (bottom graph). No survey data available for 2020.

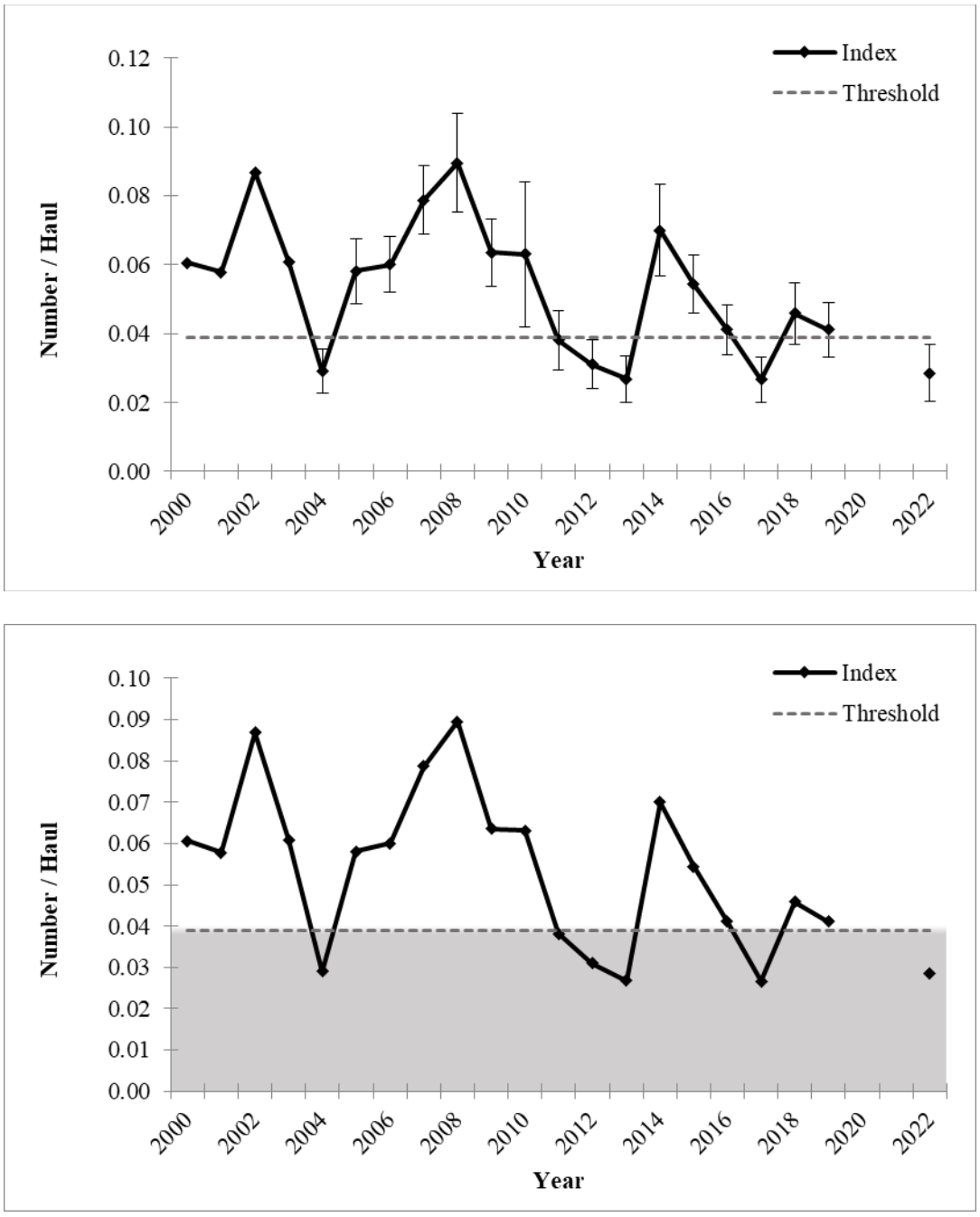


Figure 7. Female index from IGNS (January–May) for Albemarle Sound, 2000–2022. Threshold represents 25th percentile (where 75% of all values are greater. Error bars represent ±1 standard error (top graph). Values in gray are below the threshold (bottom graph). No survey data available for 2020–2021.

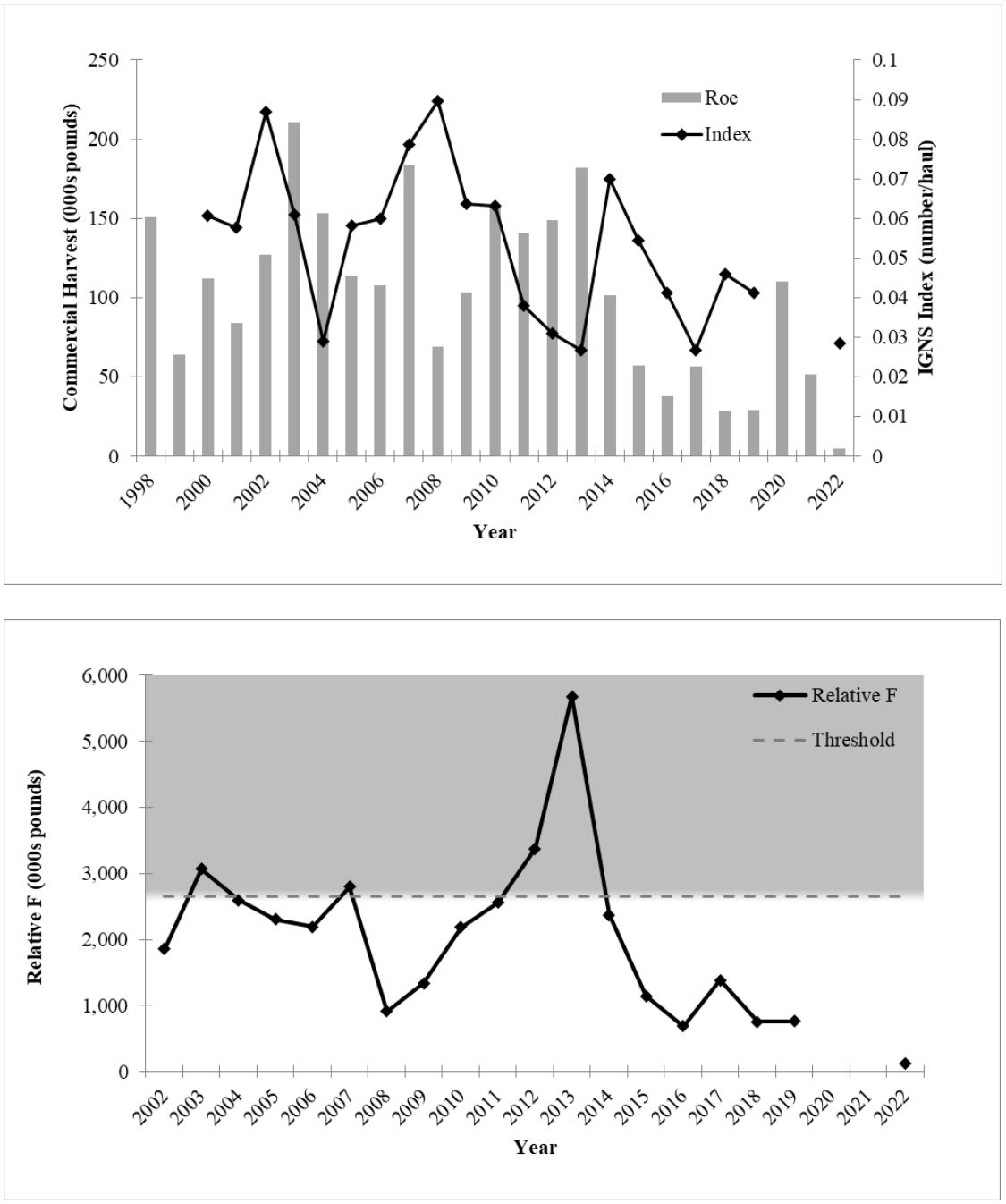


Figure 8. Albemarle Sound commercial harvest of roes by all gear types (1998–2022) compared to the female IGNS index (Jan–May 2000–2022; top graph) and annual estimates of female relative *F* based on these data (bottom graph) for Albemarle Sound expressed in pounds of female fish, 2002–2022. The threshold represents the 75th percentile (where 25% of all values are greater), values in gray are exceeding the threshold. No survey data available for 2020 and 2021 (top graph). Values for 2020–2022 based on two years of data (bottom graph).

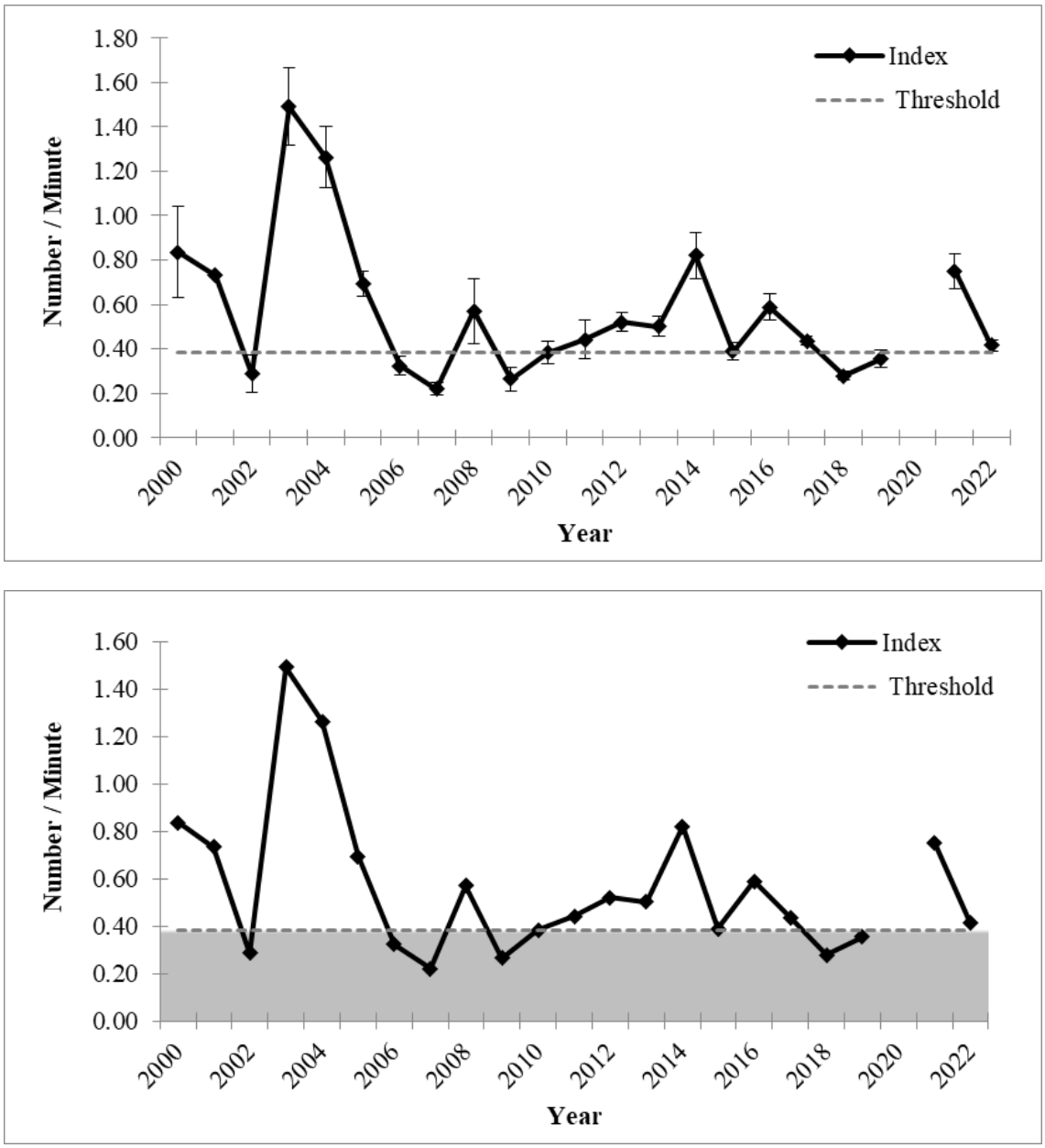


Figure 9. Female electrofishing index (March–May) for the Tar-Pamlico River, 2000–2022. The threshold represents the 25th percentile (where 75% of all values are greater). Error bars represent ±1 standard error (top graph). Values in gray are below the threshold (bottom graph). No survey data available for 2020.

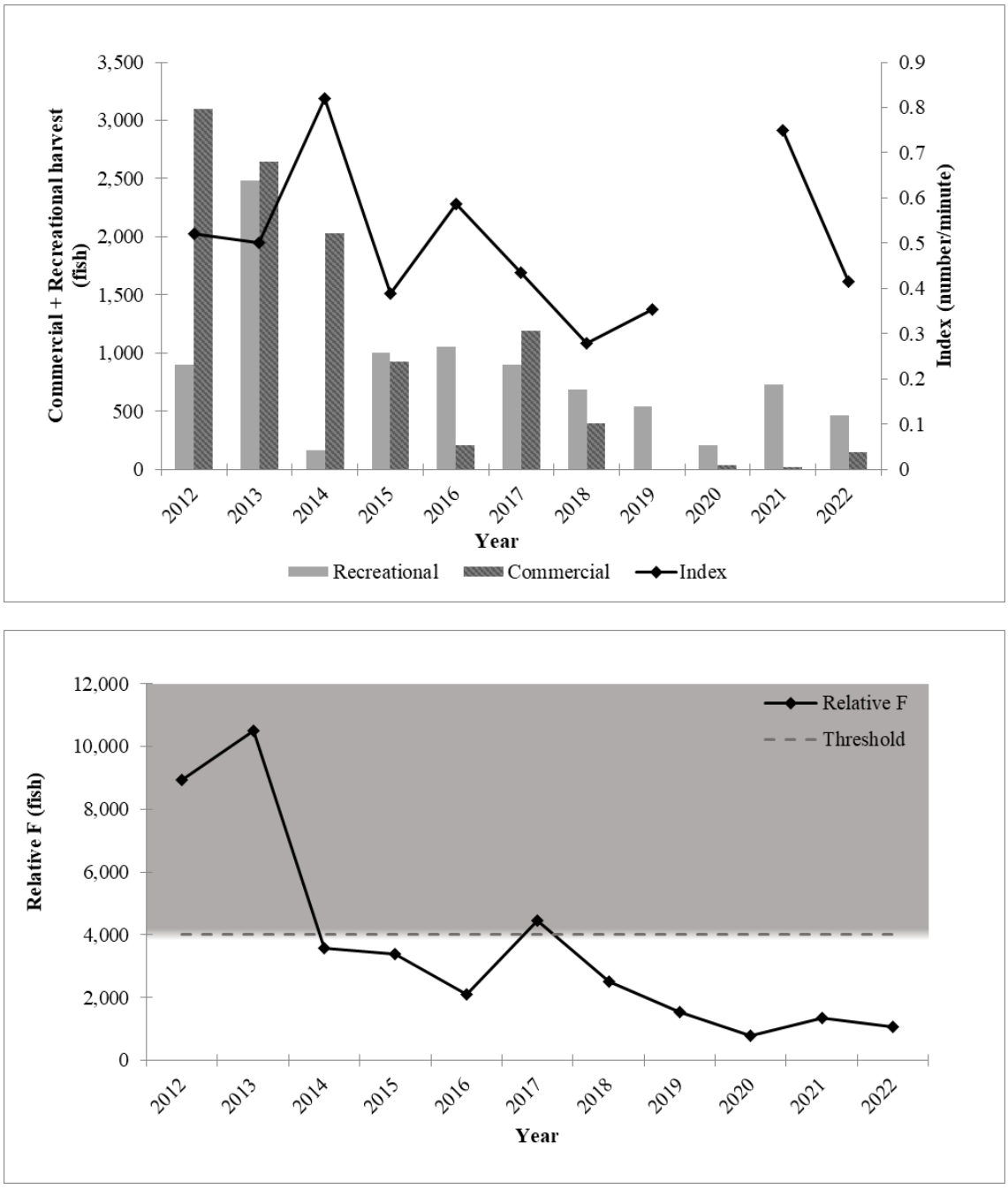


Figure 10. Total recreational and commercial harvest (all gear types and market grades) compared to the female electrofishing index (March–May, 2012-2022; top graph) and annual estimates of total relative *F* based on these data (bottom graph) for the Tar-Pamlico River expressed in numbers of fish, 2012–2022. The threshold represents the 75th percentile (where 25% of all values are greater), values in gray are exceeding the threshold. No survey data available for 2020 (top graph). Values for 2020–2022 based on two years of data (bottom graph).

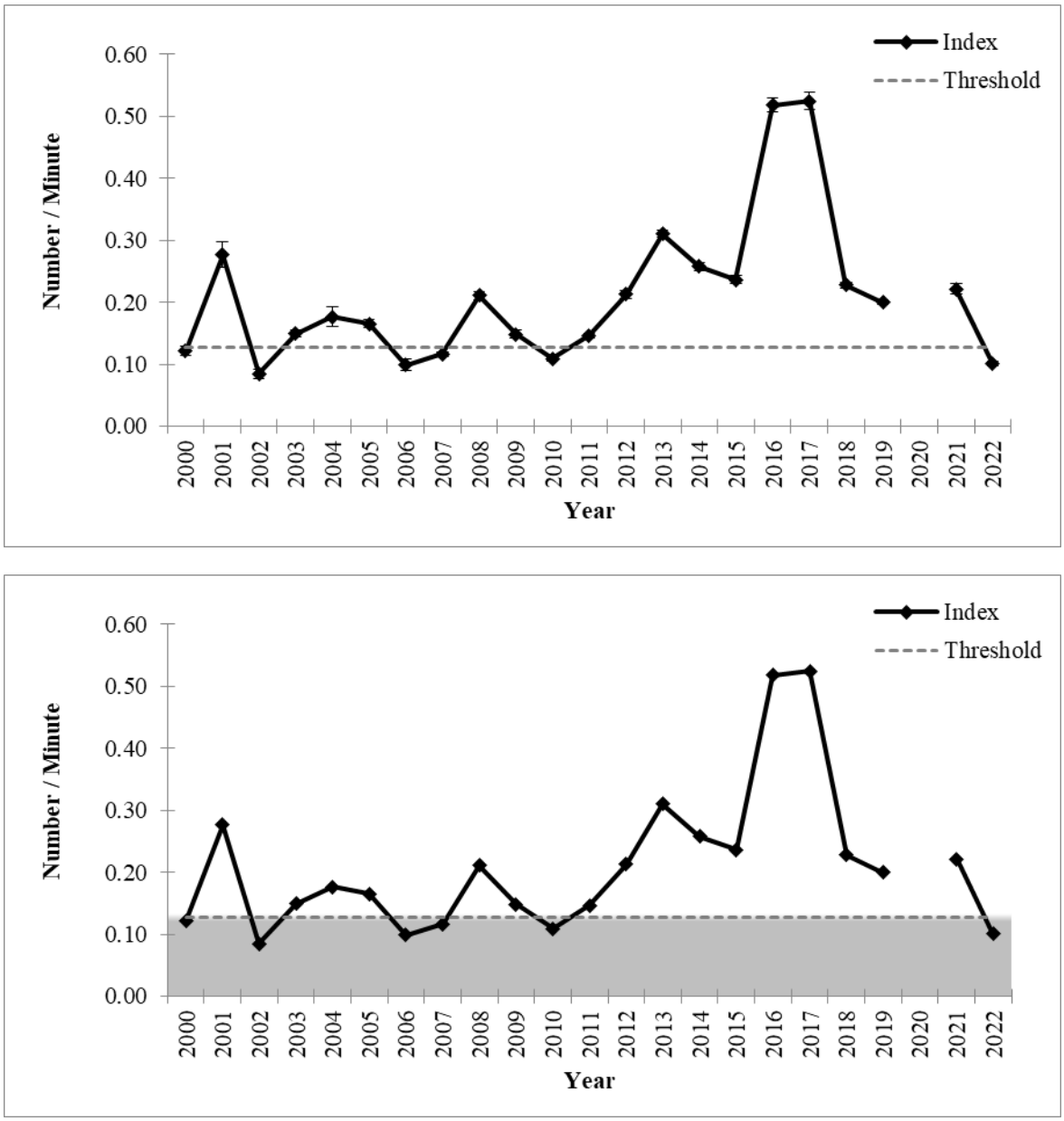
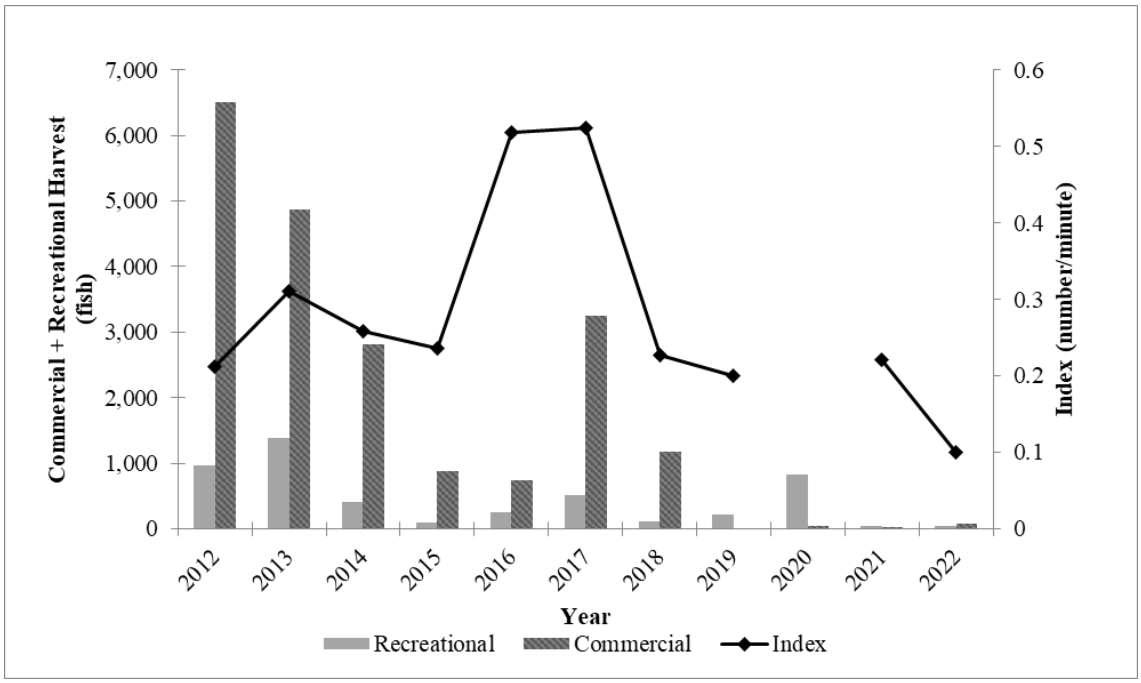


Figure 11. Female electrofishing index (March–May) for the Neuse River, 2000–2022. The threshold represents the 25th percentile (where 75% of all values are greater). Error bars represent ±1 standard error (top graph). Values in gray are below the threshold (bottom graph). No survey data available for 2020.



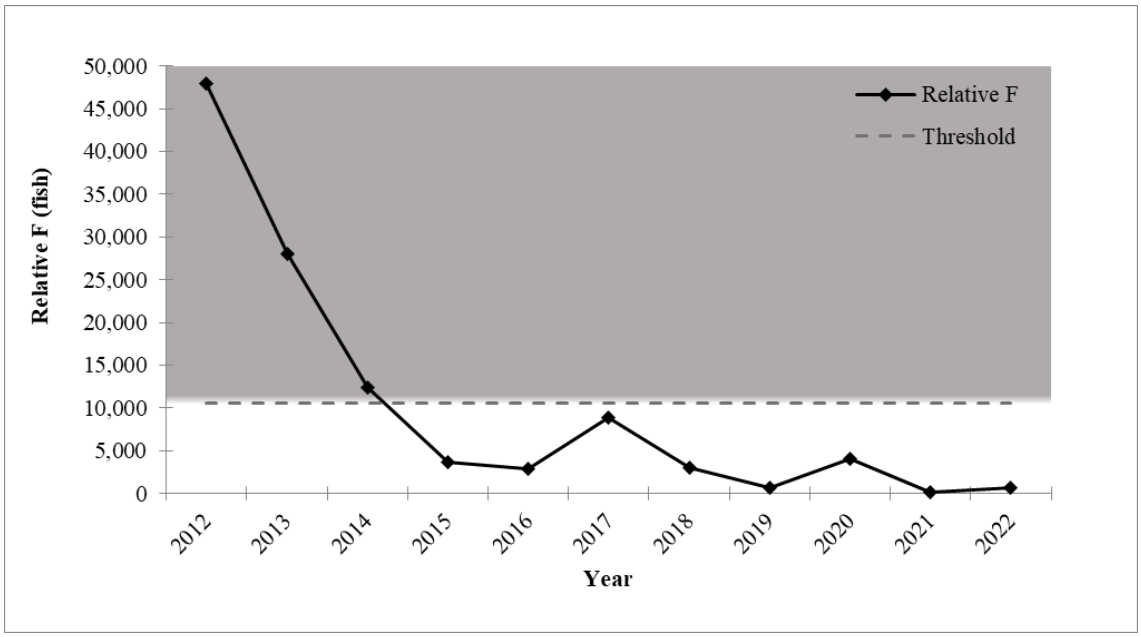


Figure 12. Total recreational and commercial harvest (all gear types and market grades) compared to the female electrofishing index (March–May, 2012-2022; top graph) and annual estimates of total relative F based on these data (bottom graph) for the Neuse River, 2002–2022. The threshold represents the 75th percentile (where 25% of all values are greater), values in gray are exceeding the threshold. No survey data available for 2020 (top graph). Values for 2020–2022 based on two years of data (bottom graph).

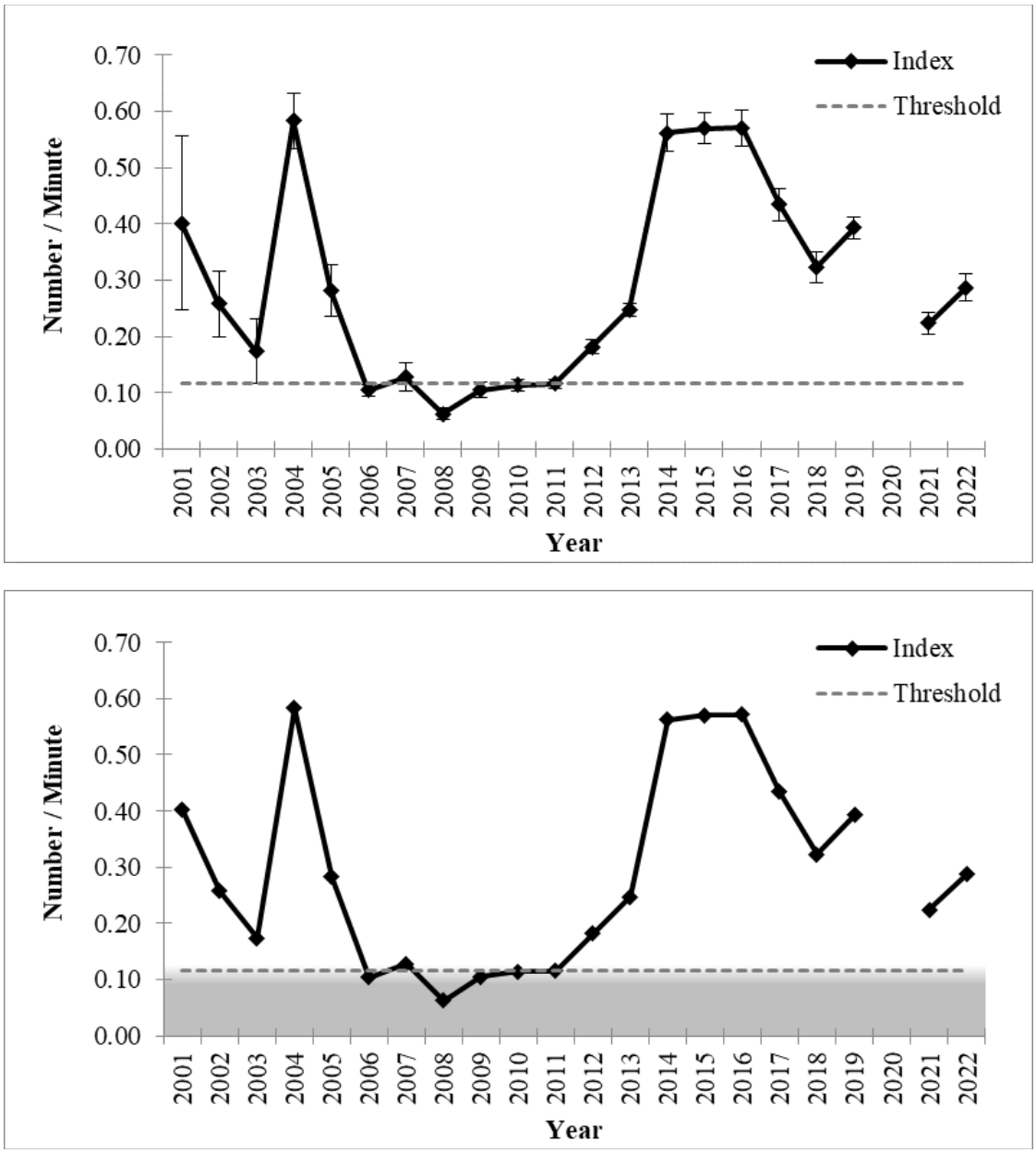
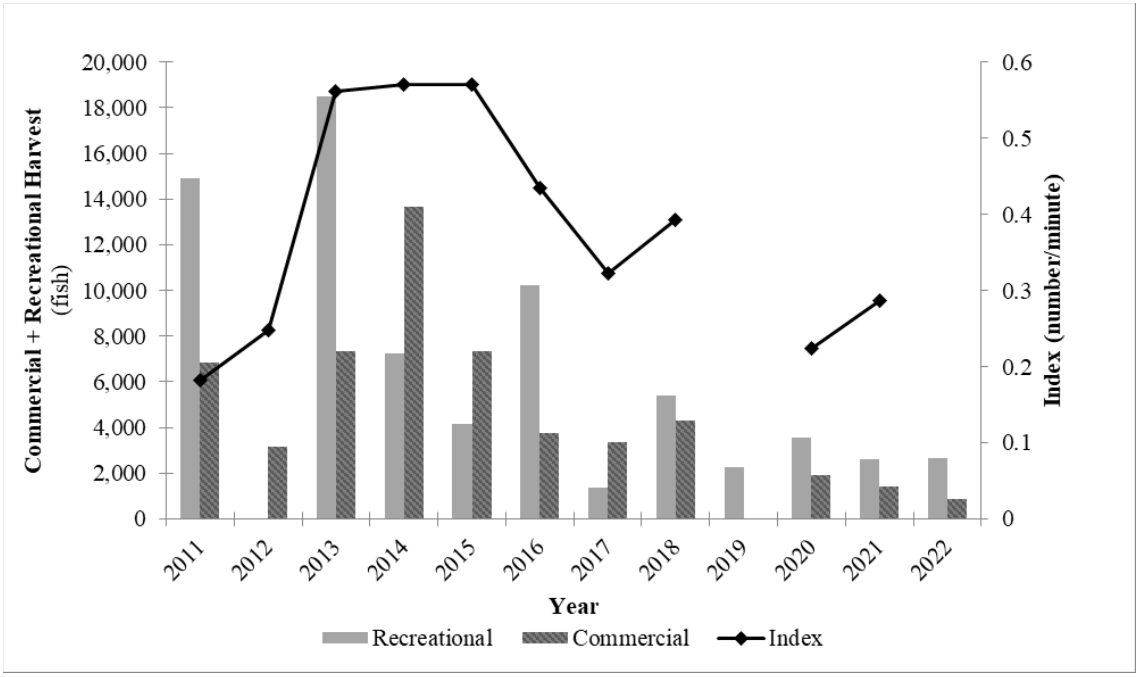


Figure 13. Female electrofishing index (March–May) for the Cape Fear River (LD-1 and LD-2, only), 2001–2022. The threshold represents the 25th percentile (where 75% of all values are greater). Error bars represent ±1 standard error (top graph). Values in gray are below the threshold (bottom graph). No survey data available for 2020.



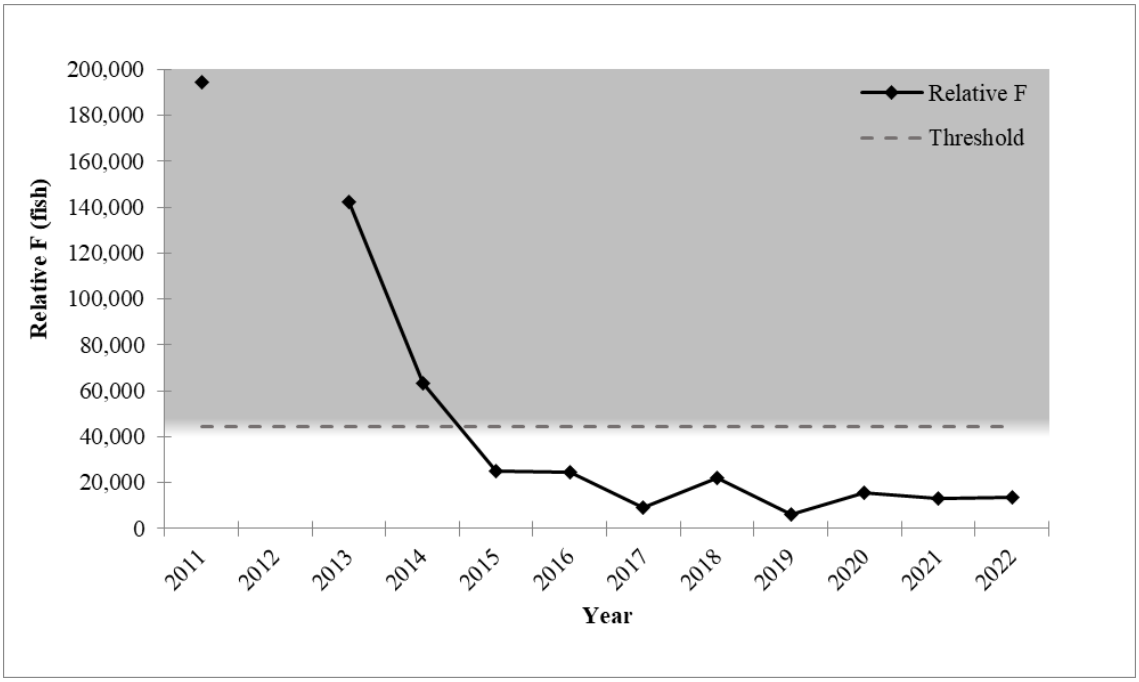


Figure 14. Total recreational and commercial harvest (all gear types and market grades) compared to the female electrofishing index (March–May, 2012-2022; top graph) and annual estimates of total relative F based on these data (bottom graph) for the Cape Fear River, 2011–2022. The threshold represents the 75th percentile (where 25% of all values are greater), values in gray are exceeding the threshold. No survey data available for 2020 (top graph). No value for 2012 due to lack of recreational data and values for 2020–2022 based on two years of data (bottom graph).

REVIEW OF THE ATLANTIC STATES MARINE FISHERIES COMMISSION FISHERY MANAGEMENT PLAN FOR SHAD AND RIVER HERRING *(Alosa spp.)* FOR THE 2021 FISHING YEAR

Shad & River Herring Plan Review Team
James Boyle, Atlantic States Marine Fisheries Commission (Chair)
Michael Brown, Maine Department of Marine Resources
Brian Neilan, New Jersey Division of Fish and Wildlife
Jim Page, Georgia Department of Natural Resources
Margaret Conroy, Delaware Division of Fish and Wildlife
Gregg Kenney, New York Department of Environmental Conservation
Matthew Jargowsky, Maryland Department of Natural Resources

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, 2022)	Approved (2012, 2019)
Connecticut		Approved (2012, 2017)
Rhode Island		
Pennsylvania		Approved* (2012, 2017, 2020, 2022)
New York	Approved (2011, 2017, 2022)	Approved* (2012, 2017, 2020, 2022)
New Jersey		Approved* (2012, 2017, 2020, 2022)
Delaware		Approved* (2012, 2017, 2020, 2022)
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). The next river herring stock assessment is expected to be completed in 2023.

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 eight million lbs, then declined to just over two million lbs 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 lbs. Since 2015, landings have remained below half a million lbs.

The total commercial landings (directed and bycatch) reported in compliance reports from individual states and jurisdictions in 2021 were 195,642 lbs, representing a 39% decrease from landings in 2020 (323,171 lbs) (Table 2). Bycatch landings accounted for approximately 17% of the total commercial landings of American shad in 2021. Landings from North Carolina, South Carolina, and Georgia accounted for 36.2%, 36.8%, and 9.7% of the directed coastwide

commercial fishery removals in 2021, respectively. The remainder of the directed landings came from Connecticut, New Jersey, 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, South Carolina, and Florida reported American shad recreational harvest estimates for 2021 (Table 3).

HICKORY SHAD:
In 2021, North Carolina, South Carolina, and Georgia reported directed commercial hickory shad landings; New York and Virginia reported bycatch landings. North Carolina accounts for a vast majority of directed landings, contributing 98% of the total. Coastwide commercial and bycatch landings in 2021 totaled 99,419 lbs, representing an 8% increase from 2020 landings (92,023 lbs) (Table 2). North Carolina and Georgia reported recreational harvest of 55,144 lbs and 112 lbs, respectively.

RIVER HERRING (BLUEBACK HERRING/ALEWIFE COMBINED):
Commercial landings of river herring declined 95% from over 13 million lbs in 1985 to about 733 thousand lbs 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 2021, the coastwide directed commercial river herring landings reported in state compliance reports were 2.11 million lbs, a 12% increase from 2020 (1.88 million lbs). Bycatch landings in 2021 totaled 451 lbs, a 99.7% decrease from the 2020 total of 167,445 lbs (Table 2). Confidential data preclude reporting commercial landings by state. North Carolina, South Carolina, and Florida provided an estimate of recreational river herring harvest in 2021; recreational harvest estimates for Maine and Massachusetts are produced by MRIP but highly uncertain (Table 3).

Table 2. Shad and river herring total commercial fishery removals (directed landings and bycatch[1], in lbs) provided by states, jurisdictions and NOAA Fisheries for 2021.

	River Herring	American Shad	Hickory Shad
Maine^	1,825,855	C	C
New Hampshire	0	0	0
Massachusetts	0	0	0
Rhode Island	0	0	^
Connecticut	0	27,233	0
New York^	2,458	1,129	C
New Jersey	0	C	0
Pennsylvania	0	0	0
Delaware	0	C	0
Maryland^	0	0	0
D.C.	0	0	0
PRFC	0	11,331	0
Virginia	0	4,246	1,955
North Carolina	0	58,885	95,372
South Carolina	278,801	59,964	C
Georgia	0	15,764	C
Florida	0	0	0
Total Directed	2,106,663	162,822	97,435
Total Bycatch	451	32,820	1,984
Total	**2,107,114**	**195,642**	**99,419**

*All values for river herring by state are not shown due to confidential data. Confidential values for American shad and hickory shad are indicated by "C." Some values are listed as confidential to protect the confidentiality of other states.
^Data not yet available.

Table 3. Recreational harvest information for river herring and American shad in 2021 from MRIP and state compliance reports.

State	River Herring Harvest	American Shad Harvest	Source of Estimates
Maine	0	0	MRIP*
New Hampshire	0		Due to failure to meet fishery-independent target in NH's SFP, the recreational river herring fishery was closed in 2021.
Massachusetts	0		MRIP*; No catch recorded
North Carolina		14,589 fish (36,546 lbs)	Recreational creel surveys on the Roanoke, Tar, Neuse, and Cape Fear rivers
South Carolina	12,385 fish (5,239 lbs)	15,200 fish (72,048 lbs)	Creel surveys and mandatory reporting for recreational gill netters.
Florida		47 fish (56kg)	Access point creel survey on St. Johns River

[1] Available information on shad and river herring bycatch varies widely by state. Estimates may not capture all bycatch removals occurring in state waters.

*MRIP estimate considered highly uncertain. 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 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 2021, several jurisdictions reared American shad, stocking a total of 16,239,677 American shad, an increase of 11% from the 14,688,667 shad stocked in 2020 (Table 5). In addition, 1,268,795 river herring (both alewife and blueback) larvae were stocked in the James river system in 2021.

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 2021.

State/River	Shad	River Herring
Maine		
Androscoggin	550	54,906
Saco	2,739	135,198
Kennebec	92	66,008
Sebasticook	7	C
Penobscot	11,581	2,852,037
St. Croix	40	550,123
New Hampshire		
Cocheco		2,117
Exeter		167,729
Oyster		9,976
Lamprey		80,567
Winnicut		0
Massachusetts		
Merrimack	47,678	203,399
Rhode Island		
Pawcatuck	65	100,110
Gilbert Stuart		32,760
Nonquit		44,341
Buckeye Brook		122,190
Connecticut River		
Holyoke Dam	237,306	
Pennsylvania		
Schuylkill (Fairmont Dam)	0	*
Pennsylvania/Maryland/Delaware		
Susquehanna (Conowingo)	6,413	27
Susquehanna (Holtwood)	^	^
Susquehanna (Safe Harbor)	^	^
Susquehanna (York Haven)	80	0
South Carolina		
St. Stephen Dam	70,921^^	17,377
Total 2021	291,397	1,160,045
Total 2020	696,556	1,188,067
Total 2019	437,853	6,543,632
Total 2018	642,688	9,404,020
Total 2017	761,386	5,876,375

*Count not completed due to impacts from COVID-19 pandemic.

**Did not collect data in 2021 due to low stock abundance

^No lift operations; ^^2021 season closed early due to mechanical failure of Gate 1

Table 5. Stocking of Hatchery-Cultured Alosine Larvae (Fry) in State Waters, 2021.

State	American Shad	River Herring
Maine		
Androscoggin River	0	0
New Hampshire		
Lamprey River	0	*
Massachusetts*		
Merrimack River	0	0
Nashua River	0	0
Rhode Island		
Pawcatuck River	1,899,929	0
Pawtuxet River	0	0
Pennsylvania		
Susquehanna River	0	0
Lehigh River	0	0
Schuykill River	0	0
Delaware		
Nanticoke River	603,000	0
Maryland		
Choptank River	1,140,000	0
Patapsco River	200,000	0
Maryland/District of Columbia/PRFC**		
Potomac River	264,100	0
Virginia		
James River	0	1,268,795
North Carolina		
Neuse River	0	0
Roanoke River	0	0
South Carolina		
Santee	12,111,381	0
Edisto River	21,267	0
Wateree River	0	0
Georgia		
Altamaha River	0	0
Oconee River	0	0
Total	**16,239,677**	**1,268,795**

*In Maine and Massachusetts river herring of wild origin are stocked as adult pre-spawning individuals through trap and transfer programs. Similarly, New Hampshire stocked river herring are adults of wild origin. 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 2021 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 2021:

- Maine (American shad)
- New Hampshire (American shad and river herring)
- Massachusetts (American shad)
- Georgia (river herring)
- 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.

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. Several states did not report on all monitoring requirements listed under Amendments 2 and 3 (see Table 6). Along with the COVID-19 pandemic, persistent funding and staffing issues prevented states from conducting the required surveys.
    a. The Delaware COOP has not conducted recreational monitoring for American shad since 2002.
    b. Massachusetts does not conduct a JAI for American shad in the Merrimack River
    c. Rhode Island takes river herring samples for mortality/survival estimates but mortality rates have not been updated since 2015.
2. Edisto River was below American shad CPUE sustainability benchmark for three consecutive years (2019-2021), but management action was not triggered.
    a. Note: 2020 monitoring was suspended after March 19th; Management measures are currently being deliberated and will be reviewed by the TC.
3. Maine, DC, and South Carolina did not provide a copy or link to their current fishery regulations.
4. Connecticut did not include a section for hickory shad reporting.

VIII. PRT Recommendations

After a thorough review of the state reports, **the PRT recommends approval of the state compliance reports for the 2021 fishing year and *de minimis* requests**. In order to further streamline the compliance review process, the PRT also recommends moving section VIII B, which provides the results of hickory shad monitoring, to the appendices. This change would allow states that conduct hickory shad monitoring a place to share the results, while removing

optional data from the main body of the compliance report. Additionally, the PRT noted that bycatch losses are inconsistently reported by jurisdictions. Given the importance of this data and the emphasis placed on bycatch by the shad stock assessment and peer review, the PRT will add a section for all states to include their sources of bycatch information to the compliance report template.

Table 6. Summary of PRT Review of 2021 State Compliance Reports.

STATE	2021 FISHERY AND MONITORING HIGHLIGHTS	UNREPORTED INFORMATION AND COMPLIANCE ISSUES
MAINE		Did not provide a copy of state regulations for American shad.
NEW HAMPSHIRE	No known passage of American shad at state monitored fishways in 2021. River herring return to monitored rivers for 2021 was 260,065 fish. Therefore, the NH fishery-independent target was exceeded in 2021	Did not include a section for habitat recommendation implementation.
MASSACHUSETTS		No JAI program; requirement for American shad to develop one in the Merrimack River.
RHODE ISLAND		Samples were taken for mortality/survival estimates for river herring but mortality rates have not been updated since 2015.
CONNECTICUT		Shad: Due to a lack of funding and staff, the spawning stock survey, calculation of mortality/survival estimates, and recreational FD monitoring were not completed. Fishery independent work completed but still processing and analyzing data. River Herring: Unable to collect spawning stock data due to funding and staffing issues. Did not include a section for hickory shad.
NEW YORK		Did not include a section for implementation of habitat recommendations. American shad: Annual spawning stock survey not completed due to COVID-19 restrictions. River herring: Spawning stock assessment, monitoring of recreational landings, and mortality estimates were not completed in 2021 due to funding and COVID-19 constraints.
NEW JERSEY	Did not complete Ocean Trawl in 2021 for shad or river herring.	

Table 6. Summary of PRT Review of 2021 State Compliance Reports.

STATE	2021 FISHERY AND MONITORING HIGHLIGHTS	UNREPORTED INFORMATION AND COMPLIANCE ISSUES
PENNSYLVANIA	Fish passage operations for adult American shad and river herring at Conowingo, Holtwood, and Safe Harbor dams were suspended during 2021 to preclude the upriver range expansion of several invasive fish species.	
DELAWARE BASIN COOP	Seine GLM Index (1988-2015) and Gillnetting CPUE Index (1990-2015) exceeded benchmark but did not trigger management action. Removal of dams 4 and 6 is planned with the permit applications currently under review. Permits submissions for dam 2 and 4 removal on White Clay Creek in Delaware are currently under review as well. Removal of additional dams on the Paulinskill and Musconetcong River in New Jersey are also being evaluated.	No recreational monitoring for American shad since 2002. Shad and river herring: NJ Tidal Beach Seine and Delaware River Beach Seine not conducted due to COVID-19; No mortality rates provided. Did not include section on implementing habitat recommendations.
DELAWARE		Did not include section on implementing habitat recommendations.
MARYLAND	Nanticoke River spawning stock survey resumed in 2021, but was conducted once per week. Shad: Due to a lack of boat access at the Conowingo Dam, the Susquehanna River/upper Chesapeake Bay spawning stock survey was conducted almost exclusively from shore in 2021, precluding fishery independent CPUE estimates; survey was conducted as normal in 2022. However, annual population estimate was calculated from the number of tagged fish recaptured in fish lifts.	
D.C.		River herring: COVID-19 work restriction prevented the completion of required fishery independent monitoring in 2020. Only an abbreviated JAI seine survey was conducted. No spawning stock survey, adult biological data, or mortality/survival estimates are available for 2020. Did not provide a copy of fishery regulations. Did not include a section for habitat recommendation implementation.
PRFC	No hatchery evaluation was conducted because COVID-19 prevented any broodstock collections.	No recreational effort for American shad. Did not include a section for habitat recommendation implementation.
VIRGINIA	Virginia is stocking prespawn river herring in the headwaters of Herring Brook to increase returns.	Did not include a section for habitat recommendation implementation.

Table 6. Summary of PRT Review of 2021 State Compliance Reports.

STATE	2021 FISHERY AND MONITORING HIGHLIGHTS	UNREPORTED INFORMATION AND COMPLIANCE ISSUES
NORTH CAROLINA		
SOUTH CAROLINA	The commercial fishery in the Black River was closed in 2021. No management actions were triggered in 2021, though the commercial CPUEs for the Pee Dee River Run, Edisto River, and Savannah River, as well as the fishery independent CPUE for The Santee-Cooper Rivers Complex, were all below sustainability benchmark values in 2021. The Pee Dee River Run was also below its sustainability benchmark in 2018 and 2019, and the Edisto River was below its sustainability benchmark in 2019.	Edisto River was below American shad CPUE sustainability benchmark for three consecutive years (2019-2021), but management action was not triggered. Did not provide a copy or link to current fishery regulations.
GEORGIA	Creel surveys on the Altamaha River were not conducted in 2021 due to internal restructuring but resumed in 2022. Effective in 2022, this creel survey is hereafter scheduled to occur every 3 years. All systems currently managed under Georgia's SFMP were above their sustainability targets in 2021. In 2021, no river herring were recorded in the state's juvenile American shad seine surveys.	
FLORIDA	For the 5th year in a row, the St. Johns River E-fish index fell below sustainability threshold, triggering a management review (triggers after 3-consective years). The state determined that the minimal harvest in recreational fishery doesn’t warrant closure. The state has also not completed ageing, though otoliths were collected. Could not calculate age frequency or mortality estimates for adult blueback in the St. Johns River due to a low sample size.	

Table 7. Reported protected species interactions (sturgeon species) in shad or river herring fisheries in 2021. 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			C	0			C	0
NJ	**	**	**	**	**	**	**	**
PRFC	4	0					4	0
VA	1	0					1	0
NC	3	1			2	0	5	1
SC	4	0					4	0
GA	20	0	5	0			25	0
Total by Species	32	1	5	0	2	0	**39**	**1**

*Rhode Island reports NOAA NEFOP and ASM data, which is available after the compliance report submission deadline. Therefore, their data lags by one year. Rhode Island reported 4 sturgeon caught in their waters in 2020.

**In 2021 gill netters in New Jersey coastal waters reported discarding 1,666 lbs of sturgeon.

Atlantic States Marine Fisheries Commission

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

MEMORANDUM

January 24, 2023

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 – Stephen Gephard, a recreational angler and retired CT DEEP biologist with over four decades of experience with diadromous species, and William Lucey, who focuses on dam removal and fish passage issues with Save the Sound. 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: James Boyle

SHAD & RIVER HERRING ADVISORY PANEL

Bolded names await approval by the Shad & River Herring Management Board

January 24, 2023

Maine

River Herring:

Deborah Wilson (conservation)
374 Bayview Road
Nobleboro, ME 04555
Phone: (207)380-6997
Deb.wilson1028@gmail.com
Appt Confirmed 5/3/22

Mike Thalhauser (comm)
Alewife Harvesters of Maine
13 Atlantic Avenue
Stonington, ME 04681
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
Appt Confirmed 2/4/21

Massachusetts

Shad & River Herring:

Paul Perra (rec)
5 Candleberry Court
Bourne, MA 02532
Phone: 978.381.4746
pperra@icloud.com
Appt Confirmed 11/8/22

Jerry Audet (rec/outdoor writer)
286 Yew Street
Douglas, MA 01516
Phone: 304.906.1298
indeepoutdoorswmedia@gmail.com
Appt Confirmed 11/8/22

Connecticut

Shad & River Herring:

Stephen Gephard (rec)
7 High Street
Deep River, CT 06417
Phone: 860.966.9344
sgephard@gmail.com

William Lucey (fish passge)
68 Titus Coan Road
Killingworth, CT 06419
203.854.5330
w.g.lucey@gmail.com

New York

Shad & River Herring:

Byron Young
53 Highview Lane
Ridge, NY 11961
Phone: (631) 821-9623
Cell: (631) 294-9612
Fax: (631) 821-9623
Email: youngb53@optimum.net
Appt. Confirmed 5/5/08
Chair from 1/09- 1/11
Confirmed interest in March 2019

New Jersey

Shad:

Vacancy – recreational

Shad & River Herring:

Jeff Kaelin (comm. trawl and purse seine)
Director of Sustainability and Government Relations
Lund's Fisheries, Inc.
997 Ocean Drive
Cape May, NJ 08204
Phone: 207.266.0440
jkaelin@lundsfish.com
Appt Confirmed 8/20/09
Confirmed interest in March 2019

Pennsylvania

Vacancy

SHAD & RIVER HERRING ADVISORY PANEL

Bolded names await approval by the Shad & River Herring Management Board

January 24, 2023

Delaware
Shad & River Herring:
Dr. Edward Hale
Delaware Sea Grant
23 Gosling Drive
Lewes, DE 19958
Phone: 302.470.3380
Ehale@udel.edu
Appt Confirmed 2/4/21

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
FAX: (919) 778-1197
Email: oldpirate.rb@gmail.com
Appt. Confirmed 5/5/08; 8/18
Confirmed interest in March 2019

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
Confirmed interest in Sept 2017

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; 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

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: Justin Davis State: Connecticut
(your name)

Name of Nominee: Stephen Gephard

Address: 7 High Street

City, State, Zip: Deep River, CT 06417

Please provide the appropriate numbers where the nominee can be reached:

Phone (day): 860-966-9344 Phone (evening): 860-966-9344

FAX: n.a. Email: sgephard@gmail.com

. . . . . .

FOR ALL NOMINEES:

1. Please list, in order of preference, the Advisory Panel for which you are nominating the above person.
   1. Shad and 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.

Connecticut River Salmon Assoc.

(recreational)

4. What kinds (species) of fish and/or shellfish has the nominee fished for during the past year?

Striped Bass

Bluefish

5. What kinds (species) of fish and/or shellfish has the nominee fished for in the past?

Atlantic Salmon

trout

black 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? >60 years

2. Is the nominee working, or has the nominee ever worked in any area related to the fishing industry? yes _____ no X

   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? ~50 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.

The formatting for this space is non-functional. Please see attached addendum.

Nominee Signature: _____ Date: 12/21/2022

Name: Stephen Gephard
(please print)

COMMISSIONERS SIGN-OFF (not required for non-traditional stakeholders)

_____
State Director

_____
State Legislator

_____
Governor's Appointee

ADDENDUM TO THE ADVISORY PANEL NOMINATION FORM- Gephard

The nominee holds a BA in Biology and a MS in Fisheries Biology and worked for 42 years with the CTDEEP Fisheries Division as a fisheries biologist, specializing in diadromous fish species. Upon retirement in 2020, he had supervised the CTDEEP's Diadromous FIsh program for nearly 20 years. During this time, he was the first chairman of the ASMFC's American Eel Technical Committee. He has extensive technical experience with both Alewife and Blueback Herring as well as knowledge with American Shad. He has co-authored technical publications on these species. He is currently a self-employed fisheries consultant specializing in diadromous fish species and fish passage and remains active in the field. He currently is a member of Steering Committee on development NOAA's River Herring Habitat Conservation Plan.

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: Justin Davis State: CT
(your name)

Name of Nominee: William Lucey

Address: 68 Titus Coan Rd.

City, State, Zip: Killingworth, CT 06419

Please provide the appropriate numbers where the nominee can be reached:

Phone (day): 203-854-5330 Phone (evening): same

FAX: _____ Email: w.g.lucey@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 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.

CT Fisheries Advisory Committee

4. What kinds (species) of fish and/or shellfish has the nominee fished for during the past year?

Black Seabass
Bluefish
Porgey
Blue Crab
Striped Bass
Hickory Shad

5. What kinds (species) of fish and/or shellfish has the nominee fished for in the past?

Pacific Salmon
Spot Prawn
Pacific Halibut
Pacific Herring
Eulachon Smelt

FOR COMMERCIAL FISHERMEN:

1. How many years has the nominee been the commercial fishing business? 17 years
2. Is the nominee employed only in commercial fishing? yes_____ no X
3. What is the predominant gear type used by the nominee? Gillnet,Troll, Longline
4. What is the predominant geographic area fished by the nominee (i.e., inshore, offshore)? Gulf of Alaska 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? 48 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.

Held a number of permits in Alaska in the past

_____

_____

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? 30 years

2. Is the nominee employed in the fishing business or the field of fisheries management?
yes _____ no X

If "no," please list other type(s) of business(es) and/or occupation(s):

Clean water and fisheries advocate for regional Environmental NGO "Save the Sound, Inc,

Job title is "Long Island Soundkeeper" member of the Waterkeeper Alliance

_____

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.

See attached letter

Nominee Signature: s// William Lucey Date:

Name: William Lucey
(please print)

COMMISSIONERS SIGN-OFF (not required for non-traditional stakeholders)

Justin Davis
State Director

State Legislator

Governor's Appointee

To: ASMFC review committee,

My interest in joining the River Herring and Shad advisory committee stems from a long career working in natural resource management including diadromous fish. I studied fisheries biology and management at the Universities of Vermont and Oregon State. I began my career in 1988 with the Vermont Fisheries and Wildlife Department and have worked on a variety of projects; stocking Atlantic salmon alevins in in the upper CT River, teaching as a fish aquaculture extensionist in Central America and working in Alaska with both the US Forest Service and as ACMP Coordinator. I have worked extensively with salmon genetic collection, radio telemetry, juvenile salmon weir and spawning escapement counts as well as regulatory proposals for the AK Board of Fish and the AK federal subsistence board. I also worked with eulachon smelt monitoring and Pacific herring spawn mapping for the AK Dept. of Fish and Game.

Currently, I focus on fisheries policy and my parent organization, Save the Sound, is involved in several dam removal and fish passage projects designed to pass river herring. On the most recent project I was able to compare 20 years of daily fish counts, during the spring runs, with daily mean high flows from a nearby USGS gauge to demonstrate lack of efficacy at an existing fish ladder. This led to a local, state and federal partnership to begin the process to remove the dam which will add over 30 miles of high-quality shad, blueback and alewife habitat to CT's watersheds. We have also been tracking the incidental catch rates of river herring in offshore fisheries described in the recent paper by Reid et al. (2022) to better understand the effects on our local populations.

I am very interested in following the river herring stock status updates from NMFS and management proposals for reversing the chronically depressed river herring populations south of Maine. To be transparent, I do not agree with the statements made by NOAA regarding distinct population segments described in the court ordered response to the removal of the New England midwater-trawl buffer zone. The NOAA attorneys asserted that the entire southern New England stock could theoretically be extirpated but that straying rates from other locations such as the CT River would be able to repopulate those rivers. While straying is an important ecological strategy, it is a significant contributor to nearby populations only when those systems are adjacent to robust healthy populations. The current CT River runs do not begin to approach a run strength that matches its historic production capacity. The entire region is depleted and I do not think straying would alleviate extirpation.

We feel that once the current stock status is completed, there will be a clearer picture of what management options are needed to bring runs back to levels that the currently available, and future habitat can support. This should be based on longer times series data, Atlantic MDO cycles along with habitat quality and incidental harvest factors. I would be glad to participate in that process as it develops and work closely with the CT fisheries management staff on solutions.