TELECONFERENCE
VIA WEBEX

NOVEMBER 19-20, 2020

NORTH CAROLINA MARINE FISHERIES COMMISSION

QUARTERLY BUSINESS MEETING

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Marine Fisheries Commission Business Meeting
AGENDA
Teleconference via WebEx
November 19-20, 2020

N.C.G.S. 138A-15(e) mandates at the beginning of any meeting of a board, the chair shall remind all members of their duty to avoid conflicts of interest under Chapter 138. The chair also shall inquire as to whether there is any known conflict of interest with respect to any matters coming before the board at that time.

N.C.G.S. 143B-289.54.(g)(2) states a member of the Marine Fisheries Commission shall not vote on any issue before the Commission that would have a "significant and predictable effect" on the member's financial interest. For purposes of this subdivision, "significant and predictable effect" means there is or may be a close causal link between the decision of the Commission and an expected disproportionate financial benefit to the member that is shared only by a minority of persons within the same industry sector or gear group. A member of the Commission shall also abstain from voting on any petition submitted by an advocacy group of which the member is an officer or sits as a member of the advocacy group's board of directors. A member of the Commission shall not use the member's official position as a member of the Commission to secure any special privilege or exemption of substantial value for any person. No member of the Commission shall, by the member's conduct, create an appearance that any person could improperly influence the member in the performance of the member's official duties.

Commissioners having questions about a conflict of interest or appearance of conflict should consult with counsel to the Marine Fisheries Commission or the secretary's ethics liaison. Upon discovering a conflict, the commissioner should inform the chair of the commission in accordance with N.C.G.S. 138A-15(e).

Thursday, November 19th

9:00 a.m. Preliminary Matters
- Commission Call to Order* - Rob Bizzell, Chairman
- Conflict of Interest Reminder
- Roll Call
- **Approval of Agenda ****
- **Approval of Meeting Minutes****

9:30 a.m. Public Comment Period

10:00 a.m. Chairman's Report
- Letters and Online Comments
- Ethics Training and Statement of Economic Interest Reminder
- 2021 Proposed Meeting Schedule
- Commission Committee Assignments
- Ethical Duty Comment

10:10 a.m. Committee Reports
- Nominating Committee – Chris Batsavage
  - **Vote on slate of nominees for the at-large seat for the Mid-Atlantic Fishery Management Council and South Atlantic Fishery Management Council****
- Joint Meeting of the MFC Commercial Resources Fund Committee and the Funding Committee for the N. C. Commercial Fishing Resource Fund

**** Times indicated are merely for guidance. The commission will proceed through the agenda until completed.***
*****Probable Action Items***

Thursday, November 19th continued…

10:20 a.m. Director's Report – Director Steve Murphey
Reports and updates on recent Division of Marine Fisheries activities

- Division of Marine Fisheries Quarterly Update
  - COVID-19 Impact Update
  - CARES Act Update
- Updates on Issues from Commissioners:
  - Recreational Hook and Line Modification Workgroup
- Informational Materials:
  - Atlantic States Marine Fisheries Commission
  - Mid-Atlantic Fishery Management Council Update
  - South Atlantic Fishery Management Council Update
  - Highly Migratory Species
  - Protected Resources Update
    - Observer Program
    - Incidental Take Permit Updates
  - Landings Updates

11:20 a.m. Break

11:25 a.m. Small Mesh Gill Net Rules Modification Information Paper – Steve Poland, Kathy Rawls

- **Vote on preferred management options to inform development of proposed rules****

12:30 p.m. Lunch Break

1:45 p.m. **Gear Restrictions as a Management Tool for Artificial Reefs in State Ocean Waters Information Paper (SMZs) – Jason Peters ****

2:45 p.m. Break

2:50 p.m. Prohibiting Repacking of Foreign Crab Meat in North Carolina Issue Paper – Shannon Jenkins and Shawn Nelson

- **Vote on preferred management option and associated proposed language for rulemaking****

3:50 p.m. 2019 Landings Overview – Brandi Salmon, Alan Bianchi, and Chris

4:10 p.m. Coastal Habitat Protection Plan

- Comments on CHPP Steering Committee Meeting– Commissioner Martin Posey
- 2021 CHPP Development Update – Anne Deaton

Friday, November 20th

9:00 a.m. Fishery Management Plans

- Status of ongoing plans – Corrin Flora

**** Times indicated are merely for guidance. The commission will proceed through the agenda until completed.***
*****Probable Action Items***

Friday, November 20th, continued…

Fishery Management Plans continued…

- Southern Flounder Fishery Management Plan – Kathy Rawls
  - Development of Amendment 3 Update– Mike Loeffler, Anne Markwith
  - **Southern Flounder FMP Amendment 3: Commercial and Recreational Sector Harvest Allocations**
- Estuarine Striped Bass Fishery Management Plan Update – Yan Li, Todd Mathes, Laura Lee, Charlton Godwin
  - Assessment Reports
  - Estuarine Striped Bass FMP Amendment 1 Revision (adaptive management)

10:30 a.m. Break

10:40 a.m. Rulemaking Update – Catherine Blum

- 2020-2021 Annual Rulemaking Cycle
  - "Package A" - Coastal Recreational Waters Monitoring, Evaluation, and Notification (7 rules)
    - Update on public comments received
    - **Vote on final approval of readoption of 15A NCAC 18A .3401-.3407 ****
  - "Package B" Update (50 rules)
    - Classification of Shellfish Growing Waters and Laboratory Procedures (14 rules)
    - Rules with minor changes relating to standards for commercial shellfish sanitation and processing procedures (21 rules)
    - Shellfish Lease User Conflicts, per S.L. 2019-37 (3 rules)
    - General Regulations: Joint (9 rules)
    - Shrimp FMP Amendment 1 Special Secondary Nursery Areas (2 rules)
    - Oyster Sanctuaries (1 rule)
- 2021–2022 Annual Rulemaking Cycle Preview

11:00 a.m. **Rule Suspensions –Kathy Rawls**

11:10 a.m. Issues from Commissioners

11:50 p.m. Meeting Assignments and Preview of Agenda Items for Next Meeting – Lara Klibansky

12:00 p.m. Adjourn

Times indicated are merely for guidance. The commission will proceed through the agenda until completed.
****Probable Action Items***

AUGUST 2020 MEETING MINUTES

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Marine Fisheries Commission Business Meeting Minutes
Virtual Meeting via WebEx
August 20, 2020

Due to COVID-19, the commission held a one-day business meeting via WebEx webinar on August 14. Members of the public submitted public comment online or via U.S. mail. To view the public comment, go to: https://files.nc.gov/ncdeq/Marine-Fisheries/08-2020-mfc-meeting-archive/08-2020-briefing-books/04-Chairman-Report.pdf

The briefing book, presentations and audio from this meeting can be found at:
http://portal.ncdenr.org/web/mf/08-2020-briefing-book

Actions and motions from the meeting are listed in **bolded** type.

BUSINESS MEETING - MOTIONS AND ACTIONS

August 20

Prior to the meeting, Commission Liaison Lara Klibansky reviewed the WebEx format, that all public comments received by the MFC Office were provided to the commissioners prior to the meeting. She also reminded the Commission that all votes were to be roll call votes and requested that all participants identify themselves before speaking.

Chairman Rob Bizzell convened the Marine Fisheries Commission business meeting at 9:00 a.m. on August 20. He stated that Doug Cross, James Kornegay and Tom Roller have been reappointed for another three-year term and the swearing-in will need to take place before the November meeting. Chairman Bizzell reminded commissioners of their conflict of interest and ethics requirements.

The following commission members were in attendance: Rob Bizzell-Chairman, Mike Blanton, Doug Cross, Tom Hendrickson, James Kornegay, Robert McNeill, Dr. Martin Posey Tom Roller and Sam Romano.

Motion by Martin Posey to approve the meeting agenda. Second by Tom Roller

Roll Call Vote			
Commissioner	**Aye**	**Nay**	**Abstain**
Doug Cross	X		
Mike Blanton	X		
Tom Hendrickson	X		

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James Kornegay	X		
Robert McNeill	X		
Dr. Martin Posey	X		
Tom Roller	X		
Sam Romano	X		
Chairman Rob Bizzell	X		

Motion carries unanimously.

Motion by Doug Cross to approve the minutes of the May 2020 meeting. Second by Pete Kornegay

Roll Call Vote			
Commissioner	**Aye**	**Nay**	**Abstain**
Doug Cross	X		
Mike Blanton	X		
Tom Hendrickson	X		
James Kornegay	X		
Robert McNeill	X		
Dr. Martin Posey	X		
Tom Roller	X		
Sam Romano	X		
Chairman Rob Bizzell	X		

Motion carries unanimously.

<u>Chairman's Report</u>

Chairman Bizzell stated that the Chairman's Report is in the briefing book for review. Commissioners were reminded they are required to take ethics training within six months of their appointment and every two years thereafter. Commissioners were also reminded of the annual requirement to submit a Statement of Economic Interest form by April 15 to the State Board of Elections and Ethics Enforcement.

It was determined the 2021 meeting schedule would be:
Feb. 17-19
May 19-21
Aug. 25-27
Nov. 17-19

It is possible the November meeting may also be conducted via WebEx due to COVID 19.

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Robert McNeill was appointed to chair the August 26 MFC public hearing for proposed rules. The Shellfish Cultivation Lease Review Committee will be meeting in a few weeks for an orientation and there is no business yet to address.

Election of Vice Chair

The commission elected Doug Cross as vice chairman.

Motion by Sam Romano to accept Doug Cross as vice chairman by affirmation. Second by Martin Posey

Roll Call Vote			
Commissioner	**Aye**	**Nay**	**Abstain**
Doug Cross			X
Mike Blanton	X		
Tom Hendrickson	X		
James Kornegay	X		
Robert McNeill	X		
Dr. Martin Posey	X		
Tom Roller	X		
Sam Romano	X		
Chairman Rob Bizzell	X		

Motion carries with no objection

Shawn Maier, the Commission's legal counsel gave a verbal presentation on the MFC power and duties.

Shellfish Lease Regulation

Steve Murphey, the Division’s director, gave a presentation on shellfish lease regulation.

This presentation can be found at:
http://portal.ncdenr.org/c/document_library/get_file?p_l_id=1169848&folderId=33852056&name=DLFE-143362.pdf

A discussion followed with the Commissioners identifying potential areas of conflict specific to their area of expertise. Chairman Bizzell stated that in light of these user conflict issues the MFC needs to consider ways to address the unexpected volume of shellfish leases. He opened the floor to a motion for this purpose.

Motion by Robert McNeill to ask the Division of Marine Fisheries staff to study the concentration of shellfish leases in given water bodies and bring recommendations based on potential user conflicts to the February Marine Fisheries Commission meeting.
Second by Mike Blanton

Roll Call Vote			
Commissioner	**Aye**	**Nay**	**Abstain**
Doug Cross	X		
Mike Blanton	X		
Tom Hendrickson	X		
James Kornegay	X		
Robert McNeill	X		
Dr. Martin Posey	X		
Tom Roller	X		
Sam Romano	X		
Chairman Rob Bizzell	X		

Motion passes unanimously

Special Management Zones in State Waters

Steve Poland, the Division's Executive Assistant for Councils provided an overview of recent actions taken by the South Atlantic Fishery Management Council to establish Special Management Zones for 30 artificial reefs in Federal waters off of North Carolina. These actions were requested by Director Murphey under Amendment 34 of the Snapper-Grouper FMP. Amendment 34 is now under review by the U.S. Secretary of Commerce. This was followed with a presentation by Jordan Byrum, the Division's Artificial Reef Coordinator, of 13 additional artificial reefs in State ocean water and the benefits of implementing similar actions.

To view the presentation, go to:
http://portal.ncdenr.org/c/document_library/get_file?p_l_id=1169848&folderId=33852056&name=DLFE-143346.pdf

Motion by Tom Roller to ask the Division of Marine Fisheries to study making nearshore reefs Special Management Zones and bring back recommendations to the November Marine Fisheries Commission meeting.
Second by Robert McNeill

Roll Call Vote			
Commissioner	**Aye**	**Nay**	**Abstain**
Doug Cross		X	

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Mike Blanton			X
Tom Hendrickson	X		
James Kornegay	X		
Robert McNeill	X		
Dr. Martin Posey	X		
Tom Roller	X		
Sam Romano		X	
Chairman Rob Bizzell	X		

Motion passes 6-2 with one abstention

Committee Reports

Chairman Bizzell pointed out the Joint Meeting of the MFC Commercial Resource Fund Committee and the Funding Committee for the NC Commercial Fishing Resource Fund meeting minutes are in the briefing materials for review.

Director's Report

Division of Marine Fisheries Director Steve Murphey welcomed back the three returning commissioners and then updated the commission on division activities occurring since the May 2020 business meeting, including:

- Acknowledged staff for their continuing and remarkable work they have been doing since the beginning of the pandemic.
- There was one legislative update. Brunswick County has had a Lease Moratorium since 1967, however, a small area in Brunswick County has now been made available to lease.
- COVID-19 Impacts Update including: DMF offices remain closed to the public and with minimal staff in office. Most most staff continue to telework. Staff have adjusted remarkably well to electronic meeting format. Budget impacts are unknown, but expected to be substantial.
- A CARES Act Update was provided. There are $5.4 Million was allocated to North Carolina, $300 million were allocated for fisheries nationwide. We have worked closely with NOAA to develop our distribution process. An application process will be used to distribute funds once the process is determined.
- Update on Southern Flounder was provided. Significant reductions were taken with the adoption of Amendment 2. While the 62%/72% reductions were not met for a number of reasons, the statutorily required mandate to end overfishing was achieved. Amendment 3 is now under development and will be looking at continuing to rebuild the stock.
- The Director requested the commission provide input on the current allocation of the fishery as soon as possible. No comments were provided during the meeting.
- An update on the Estuarine Striped Bass FMP review process was provided. The last assessment, which included data from 2014, predicted that the current management was sustainable. However, following the most recent assessment, the stock has been

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determined to be overfished and overfishing is occurring. To address this status we will be implementing adaptive management that is part of the current plan. It was noted that other factors, other than fishing mortality, appear to be impacting the sustainability of this fishery. The DMF and WRC are exploring that further.

- Provided a statement on a recent request by the North Carolina Fisheries Association Board to increase allowable bycatch of red drum during the commercial southern flounder season. A modest increase of 10 fish per day would not risk cap overages and would likely reduce the number of dead fish during the short flounder season. The Director asked for comments or questions.
  - Commissioners Roller, McNeill, and Kornegay provided comments expressing opposition to the increase.
  - Commissioners Cross and Blanton provided comments in support of the increase.
- Provided an overview of the Issues from Commissioners and requested the commission provide prioritization.
- Provided an overview of environmental factors that are impacting fisheries but which the MFC/DMF do not regulate. Specifically discussed algal blooms in the Albemarle Sound.
- Described the recent Artificial Reef Vessel sinking of the 180 ft. Brian Davis.
- Provided updates on staff changes within the division.

2021 Coastal Habitat Protection Plan Update

Anne Deaton and Jimmy Johnson gave a presentation on the 2021 Coastal Habitat Protection Plan. They presented two of the five information papers and informed the MFC of the expected vote in November to send for approval to take all five information papers out for public comment.

To view the presentation, go to:
http://portal.ncdenr.org/c/document_library/get_file?p_l_id=1169848&folderId=33852056&name=DLFE-143359.pdf

Stock Overview Report

Lee Paramore, Fisheries Management Biological Supervisor, provided the commission with the 2020 Stock Overview Report.

To view the presentation, go to:
http://portal.ncdenr.org/c/document_library/get_file?p_l_id=1169848&folderId=33852056&name=DLFE-143348.pdf

Fishery Management Plan Update

Catherine Blum, the division's Fishery Management Plan Coordinator, gave the commission a presentation on the status of North Carolina's ongoing fishery management plans.

To view the presentation, go to:
http://portal.ncdenr.org/c/document_library/get_file?p_l_id=1169848&folderId=33852056&name=DLFE-143506.pdf

Bay Scallop Fishery Management Plan Update

Jeff Dobbs, the species lead for bay scallop, provided a presentation of the annual update on the Bay Scallop Fishery Management Plan. No management changes are needed, thus the DMF recommended that annual update be approved as the scheduled review.

To view the presentation, go to:
http://portal.ncdenr.org/c/document_library/get_file?p_l_id=1169848&folderId=33852056&name=DLFE-143353.pdf

Motion by Martin Posey to approve the Bay Scallop Fishery Management Plan annual update as the scheduled review.
Seconded by Doug Cross

Roll Call Vote			
Commissioner	**Aye**	**Nay**	**Abstain**
Doug Cross	X		
Mike Blanton	X		
Tom Hendrickson	X		
James Kornegay	X		
Robert McNeill	X		
Dr. Martin Posey	X		
Tom Roller	X		
Sam Romano	X		
Chairman Rob Bizzell	X		

Motion passes unanimously

Kingfishes Fishery Management Plan

Kevin Brown, species lead for kingfishes, provided the commission with an update on the Kingfishes Fishery Management Plan. No management changes are needed, thus the DMF recommended that the annual update be approved as the scheduled review.

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To view the presentation, go to:
http://portal.ncdenr.org/c/document_library/get_file?p_l_id=1169848&folderId=33852056&name=DLFE-143350.pdf

Motion by Doug Cross to approve the Kingfishes Fishery Management Plan annual update as the scheduled review. Second by Martin Posey

Roll Call Vote			
Commissioner	**Aye**	**Nay**	**Abstain**
Doug Cross	X		
Mike Blanton	X		
Tom Hendrickson	X		
James Kornegay	X		
Robert McNeill	X		
Dr. Martin Posey	X		
Tom Roller	X		
Sam Romano	X		
Chairman Rob Bizzell	X		

Motion passes unanimously

FMP Five-Year Schedule
Catherine Blum, the division's Fishery Management Plan Coordinator, gave the commission a presentation on the five-year fishery management plan review schedule.

To view the presentation, go to
http://portal.ncdenr.org/c/document_library/get_file?p_l_id=1169848&folderId=33852056&name=DLFE-143506.pdf

Motion by Martin Posey to give preliminary approval of the draft five-year fishery management plan review schedule as presented by the Division of Marine Fisheries. Second by Pete Kornegay

Roll Call Vote			
Commissioner	**Aye**	**Nay**	**Abstain**
Doug Cross	X		
Mike Blanton	X		
Tom Hendrickson	X		
James Kornegay	X		
Robert McNeill	X		
Dr. Martin Posey	X		

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Tom Roller	X		
Sam Romano	X		
Chairman Rob Bizzell	X		

Motion passes unanimously

<u>Standard Commercial Fishing License Eligibility Report</u>

Captain Garland Yopp with the Marine Patrol and chairman of the Standard Commercial Fishing License Eligibility Board gave a presentation to the commission on the annual Standard Commercial Fishing License Eligibility Pool process and reviewed the number of licenses available for the pool for the 2020-2021 license/fiscal year.

The commission set the number of Standard Commercial Fishing Licenses available through the Eligibility Pool for the 2020-2021 fiscal year at 500.

To view the presentation, go to:
http://portal.ncdenr.org/c/document_library/get_file?p_l_id=1169848&folderId=33852056&name=DLFE-143351.pdf

Motion by Mike Blanton to set the annual temporary cap on the number of Standard Commercial Fishing Licenses in the FY 2020-2021 Eligibility Pool at 500.
Seconded by Doug Cross

Roll Call Vote			
Commissioner	**Aye**	**Nay**	**Abstain**
Doug Cross	X		
Mike Blanton	X		
Tom Hendrickson	X		
James Kornegay	X		
Robert McNeill	X		
Dr. Martin Posey	X		
Tom Roller	X		
Sam Romano	X		
Chairman Rob Bizzell	X		

Motion passes unanimously

<u>Rulemaking Update</u>

Catherine Blum, the division's Rulemaking Coordinator, provided the commission with an update on 2020-2021 Annual Rulemaking Cycle and asked the commission to approve Notice of Text for Rulemaking, including the corresponding fiscal analyses, for the 50 rules in "Package B".

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To view the presentation, go to:
http://portal.ncdenr.org/c/document_library/get_file?p_l_id=1169848&folderId=33852056&name=DLFE-143352.pdf

Motion by Martin Posey to approve the proposed rules and associated fiscal analysis for Notice of Text for Rulemaking, per G.S. 150B-21.3A, for:

- **15A NCAC 18A .0431, .0704, .0901-.0910, .0913, and .0914 (shellfish growing waters).**
- **15A NCAC 18A .0140-.0143, .0146, .0150, .0154, .0155, .0159, .0160, .0163, .0167, .0169-.0172, .0179, .0180, and .0188-.0190 (shellfish sanitation and processing).**
- **15A NCAC 03O .0201, .0202, and .0204 (shellfish lease user conflicts).**
- **15A NCAC 03Q .0101-.0109 (general regulations: joint).**
- **15A NCAC 03R .0104 and .0105 (Special Secondary Nursery**

Areas). Seconded by Robert McNeill

Roll Call Vote			
Commissioner	**Aye**	**Nay**	**Abstain**
Doug Cross	X		
Mike Blanton	X		
Tom Hendrickson	X		
James Kornegay	X		
Robert McNeill	X		
Dr. Martin Posey	X		
Tom Roller	X		
Sam Romano	X		
Chairman Rob Bizzell	X		

Motion carries unanimously

Motion by Robert McNeill to approve the proposed rule and associated fiscal analysis for Notice of Text for Rulemaking to amend 15A NCAC 03R .0117 (oyster sanctuaries).

Seconded by Doug Cross

Roll Call Vote			
Commissioner	**Aye**	**Nay**	**Abstain**
Doug Cross	X		
Mike Blanton	X		
Tom Hendrickson	X		
James Kornegay	X		
Robert McNeill	X		

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Dr. Martin Posey	X		
Tom Roller	X		
Sam Romano	X		
Chairman Rob Bizzell	X		

Motion carries unanimously

Issues from Commissioners

Commissioner Hendrickson – stated that he was absolutely blown away by the shellfish lease mapping tool; it is great, and it makes the process much more transparent.

Commissioner Roller – stated that he would like to see if we can get some information about trying to figure out ways for the public to be able to clean up some of these crab pots. What options might be there for people to do this.

Commissioner Posey – asked about the timeline for the Shellfish Aquaculture Enterprise Areas. Jacob Boyd answered that we're working on a plan for Bogue Sound to begin on the heels of the pilot study. COVID has put us behind, but we are working on it. Do not have a good timeline at the moment.

Lara Klibansky reviewed the meeting assignments and previewed the Nov. MFC business meeting agenda.

The meeting adjourned at approximately 4:15 p.m.

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CHAIRMAN'S REPORT

LETTERS & ONLINE COMMENTS

ETHICS TRAINING & SEI REMINDER

2021 PROPOSED MEETING SCHEDULE

COMMISSION COMMITTEE ASSIGNMENTS

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LETTERS & ONLINE COMMENTS

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From: Klibansky, Lara
To: Gillikin, Dana
Subject: FW: [External] Proposed flounder amendment 3
Date: Tuesday, October 27, 2020 10:44:06 AM

Lara K. J. Klibansky
Marine Fisheries Commission Liaison
Executive Assistant for Councils and Commissions
NC Division of Marine Fisheries
Department of Environmental Quality

252 808 8021 office (direct)
252 515 6020 mobile
252 726 7021 main
Lara.Klibansky@ncdenr.gov

P.O. Box 769
3441 Arendell Street
Morehead City, NC 28557

From: Bizzell, Rob <r.bizzell.mfc@ncdenr.gov>
Sent: Monday, October 26, 2020 7:39 PM
To: Klibansky, Lara <Lara.Klibansky@ncdenr.gov>
Subject: Fwd: [External] Proposed flounder amendment 3

For the books
Get Outlook for iOS

From: Stuart Creighton [redacted]
Sent: Monday, October 26, 2020 3:58 PM
To: Bizzell, Rob; robert.b.mcneill@ncdenr.gov; Kornegay, K; Roller, Thomas N; Cross, Doug; Romano, Sam; Blanton, Mike; martin.posey@ncdenr.gov; Hendrickson, Tom
Subject: [External] Proposed flounder amendment 3

Good afternoon all,

I have spent some time going through the newly proposed draft of amendment 3 for the southern flounder FMP. I must tell you that I have several issues with this draft, and find it lacking in many ways.

For the proposed flounder quota, all that was done was to take the 2017 baseline date and cut it by 72%. Doing so keeps everything the same. The commercial fishery keeps their 72% of the allowable harvest and the recreational fishermen are allowed 28%. I do not feel that this is an equitable allocation. Let us not forget that flounder have been overfished with overfishing continuing to occur for 30 years, and that overfishing responsibility falls SQUARELY on the commercial industry. In that time, every attempt at action by the division was rebuffed by the commercial lobby or by members of the MFC with commercial interests. From ignoring the science to lobbying efforts, to a recent lawsuit that has handcuffed the DMF until this most recent stock assessment, the NCFA and its allies has stonewalled any significant cuts or limits to the flounder fishery. On the other side, the recreational bag limit has been cut and cut and cut to meet the needed reductions in the flounder fishery. Once again, in the face of these Draconian cuts, you continue to reward the commercial industry with the lion's share of the catch even though they are the ones directly responsible for putting us all in this unenviable position. That simply can't be allowed. A more equitable allocation should instead be implemented, at minimum 40% going to the recreational anglers, even though 50% would be most appropriate.

As far as the proposed quota is concerned, I must start by saying that NO FORM OF QUOTA WILL WORK UNTIL THE DMF DEALS WITH THE ISSUE OF LATENT LICENSES.
Regardless of the poundage that is set, when you have over 3000 inactive commercial licenses, your quota of allowable harvest is destined for failure. For the past two years during flounder season (and outside of it) hundreds of commercial fishermen go out to net or gig for "personal consumption". No trip tickets are filed, and countless flounder are harvested and sold out of the back of a truck with no knowledge that they have been removed from the stock. The magnitude of the problem is far greater than the Division is willing to acknowledge, and until the number of available licenses is reigned in and/or sufficient enforcement officers are placed on active duty patrolling our waters, any proposed quota will be inaccurate.
Under this current proposal, commercial gears will be split into mobile (gigs and gill nets) and pound nets, with each type being allowed to harvest approximately 195000 pounds of flounder, a near 50/50 split. Each gear type will have independent management zones, allowing for flexibility with seasonal openings/closures that are staggered. Previous divisional statistics show that the pound netters could potentially blow through their quota in less than a week. Is the Division really going to halt all pound netting after such a potentially short time in the water? The quota calls for daily monitoring: does the division really have the personnel to undertake such a task? With the shortened seasons, large mesh gill nets have been/will be set in incredible numbers causing bycatch of red drum, sea turtles, and more to skyrocket. How will the Division handle this issue? There has never been a more appropriate time to remove large mesh gill nets from the flounder fishery. With the staggering reductions that must be enacted, the wastefulness of the gear, and the abysmal failure that is the ITP observer program, it is obvious that it is time to ban this gear once and for all.

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That portion of the quota can be reassigned to the giggers and pound netters.

On the recreational side of the fishery, the Division is proposing a one fish per day bag limit during the season going forward, something that will not go over well with recreational anglers and needs to be re-thought immediately. In an attempt to "ease the burden", a token one ocellated flounder per day, primarily in the ocean is being proposed for March 1 through April 15. They are also allowing gig fishermen such a small fraction of the quota that it is honestly not worth the effort (15,500 pounds I believe), As I mentioned earlier in this letter, the recreational quota should be increased from 27% to a minimum of 40%. Reducing the bag limit to 2 fish would be more reasonable for southern flounder ONLY. A 45 day season for ocellated flounder continuing the 4 fish daily limit should instead be offered when you can actually fish in the ocean, somewhere between June and August. ALL RECREATIONAL COMMERCIAL GEAR SHOULD BE BANNED. Also, to reduce recreational mortality, circle hooks should be required for anyone fishing with live or cut bait.

Finding a way to manage a fishery with such a depleted stock is certainly a tough task, and an unenviable one. However, what the DMF is currently proposing is just not right and more thought needs to be put into such a plan. I hope the solutions I have proposed for are sensible. I certainly feel that they are more equitable.
In summary, reduce the commercial quota to 50 60% of the allowable harvest while eliminating large mesh gill nets. In addition, the Division must significantly change the system so that 3000 latent licenses will no longer be allowed. For the recreational side of the industry, increase the allocation to a minimum of 40%, decrease the southern flounder bag limit to 2 fish, while allowing for an ocellated flounder season that maintains the four fish daily limit during a more appropriate time of the year. Ban all recreational commercial gear, and require circle hooks when fishing natural bait for flounder.

Thank you for your consideration in this matter,

Sincerely,
Stuart Creighton
[redacted], NC

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From: Klibansky, Lara
To: Gillikin, Dana
Subject: FW: [External] DMF Public Meeting Comment Regarding Abuse of Coastal Fisheries
Date: Tuesday, October 27, 2020 10:44:33 AM

Lara K. J. Klibansky
Marine Fisheries Commission Liaison
Executive Assistant for Councils and Commissions
NC Division of Marine Fisheries
Department of Environmental Quality

252 808 8021 office (direct)
252 515 6020 mobile
252 726 7021 main
Lara.Klibansky@ncdenr.gov

P.O. Box 769
3441 Arendell Street
Morehead City, NC 28557

Email correspondence to and from this address is subject to the North Carolina Public Records Law and may be disclosed to third parties

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From: Bizzell, Rob <r.bizzell.mfc@ncdenr.gov>
Sent: Monday, October 26, 2020 11:22 AM
To: Klibansky, Lara <Lara.Klibansky@ncdenr.gov>
Subject: Fwd: [External] DMF Public Meeting Comment Regarding Abuse of Coastal Fisheries

For the books
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From: Bizzell, Rob <r.bizzell.mfc@ncdenr.gov>
Sent: Monday, October 26, 2020 11:21 AM
To: Ben Manfredi
Subject: Re: [External] DMF Public Meeting Comment Regarding Abuse of Coastal Fisheries

Thanks for your comments, I will share them with the Commission. Rob

Get Outlook for iOS

From: Ben Manfredi [redacted]
Sent: Monday, October 26, 2020 11:03:59 AM
To: Bizzell, Rob <r.bizzell.mfc@ncdenr.gov>
Subject: [External] DMF Public Meeting Comment Regarding Abuse of Coastal Fisheries

Hi Rob,

I hope you had a great weekend and this email finds you well. I'm writing to you to express my (and many other recreation fishermans) opinions in regards to the health of our fisheries in Wilmington NC, and other coastal waters. I think it's safe to say, and well known, that we allow practices that negatively affect the health of our fisheries. Examples of practices, are the use of Gill Nets for commercial fishing and allowing flounder gigging. These two practices have completely decimated the populations of the fish in the Wilmington area. I will share my opinions on each below.

1. Flounder Gigging
- Why is this allowed? It's not fishing, it's hunting. I have seen multiple times people get their limit of (4) flounder, come to the boat ramp and drop them off, and then head back out to get more. Is the limit even being enforced? I understand we can't generalize and say everyone does this, but I think it's certain that enough people do it to harm the numbers of the population. This is not a sustainable way of harvesting these fish. I've heard rumors of making the season longer with an allowable (1) flounder per trip. I think this is a GREAT idea as it will help prevent the allure of gigging and "limiting out".

2. Gill Nets.
- OK, why is NC one of the few states that still allows this barbaric harvesting method? Just last week I saw a skiff with a basket loaded full of redfish and the the front of the skiff filled with gill nets. These did not appear to be commercial fisherman, and there is no reason all those fish should have died (a few over slot too). This is a horrible thing we allow that is destroying the numbers of these beautiful fish. Even the fish that are released will likely not make it after the injuries sustained from the net (open wounds, damages to gill removing the fish from the net, ect..) This does not only apply to Redfish, but other desired inshore fish like flounder and trout (speckled).

Is there a reason behind why we allow these practices even though most other states have banned these practices and have much healthier fisheries? Are we really that blind to the positives of banning these practices. I just wanted to share my opinion and frustrations as an avid inshore fisherman. Thank you!

Best Regards,

Ben

--

From: Klibansky, Lara
To: Bizzell, Rob; Blanton, Mike; Cross, Doug; Hendrickson, Tom; Kornegay, K; McNeill, Robert; Posey, Martin H; Roller, Thomas N; Romano, Sam
Cc: Murphey, Steve; Gillikin, Dana; Loeffler, Michael; Markwith, Anne; Rawls, Kathy
Subject: FW: [External] Marine Fisheries Commission
Date: Wednesday, August 26, 2020 6:30:04 AM

Good morning, Chairman Bizzell and Commissioners,

Please see the email below.

Best,

Lara

Lara K. J. Klibansky
Marine Fisheries Commission Liaison
Executive Assistant for Councils and Commissions
NC Division of Marine Fisheries
Department of Environmental Quality

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Morehead City, NC 28557

-----Original Message-----
From: JIMMY HORTON [redacted]
Sent: Tuesday, August 25, 2020 10:27 AM
To: Klibansky, Lara <Lara.Klibansky@ncdenr.gov>
Subject: [External] Marine Fisheries Commission

Thanks for you'll work for our state . On the subject of flounder fishing , Food for thought , would you'll data support a one fish per person per day April through Sept , this will be the only opened season . My thoughts the flounder would not be the targeted fish like they are under the current season . They would basically be a by catch bonus   Thanks for considering this

Sent from my iPhone

From: Bizzell, Rob
To: [redacted] Maier, Shawn; Rawls, Kathy; Klibansky, Lara; Gillikin, Dana; Murphey, Steve
Subject: Re: [External] FW: RE: Flounder
Date: Wednesday, August 26, 2020 11:40:08 AM

Dear Mr. Strickland, thank you for your concerns on our existing flounder regulations. I would be happy to address all your concerns, but my typing fingers would not make it through the full explanation! But in short, these are the current regulations that were developed in amendment 2 of the southern flounder FMP, which went through extensive study and public comment. We are currently working on amendment 3, where some regulations could be changed, if appropriate. While the pandemic has reduced our ability to meet face to face, your input, comments, and suggestions would be welcomed. Please forward any to the DMF for consideration. Flounder are in tuff shape, requiring dramatic measures to help save the stock. Thank you for your concerns, Rob Bizzell, chairman, NCMFC

Get [Outlook for iOS]

From: Gillikin, Dana <Dana.Gillikin@ncdenr.gov>
Sent: Wednesday, August 26, 2020 11:17:08 AM
To: Bizzell, Rob <r.bizzell.mfc@ncdenr.gov>; Maier, Shawn <Smaier@ncdoj.gov>
Cc: Klibansky, Lara <Lara.Klibansky@ncdenr.gov>
Subject: FW: [External] FW: RE: Flounder

Good morning, Chairman Bizzell,

Please see the email below.

Best,

Dana H. Gillikin
Administrative Specialist, Commission Office
Division of Marine Fisheries
NC Department of Environmental Quality

Office: 252-808-8022
Dana.Gillikin@ncdenr.gov

PO Box 769
3441 Arendell Street
Morehead City, NC 28557

From: Rawls, Kathy <kathy.rawls@ncdenr.gov>

Sent: Tuesday, August 25, 2020 4:39 PM
To: Klibansky, Lara <Lara.Klibansky@ncdenr.gov>
Cc: Gillikin, Dana <Dana.Gillikin@ncdenr.gov>
Subject: FW: [External] FW: RE: Flounder

Please see his request to forward his email to the MFC chair.

Thanks,
Kat

Kathy Rawls
Section Chief, Fisheries Management
N.C. Division of Marine Fisheries
N.C. Department of Environmental Quality
(252) 808-8074 Office
Kathy.Rawls@ncdenr.gov
3441 Arendell Street
P.O. Box 769
Morehead City, NC 28557

From: revjackie [redacted]
Sent: Tuesday, August 25, 2020 4:28 PM
To: Rawls, Kathy <kathy.rawls@ncdenr.gov>
Subject: [External] FW: RE: Flounder

Sent from my Verizon, Samsung Galaxy smartphone

-------- Original message --------
From: revjackie [redacted]
Date: 8/25/20 4:17 PM (GMT-05:00)
To: revjackie [redacted]

Subject: RE: Flounder

Please forward my email to the head commissioner please. I would appreciate an answer to my legitimate concerns. Thank you

Sent from my Verizon, Samsung Galaxy smartphone

-------- Original message --------
From: revjackie [redacted]
Date: 8/18/20 6:09 PM (GMT-05:00)
To: "Rawls, Kathy" <kathy.rawls@ncdenr.gov>
Subject: Flounder

Hello
I fish section e. In brunswick county. All of our equipment has been banned except gigs. Meaning we can not set any type of net or trawl for flounder. Recreational season just opened for 1.5 months. My season opens oct 2 for one month
Is it fair that I have to fish behind all the recreational giggers and guides? As a gigger I have to put up with tides, storms, moon , wind etc. The fishermen up north where pound nets are legal will catch more flounder in one day than I can catch all month. The comission is not being fair to us down south. We should have a longer season even if we have a creel limit.
Also a rod and reel is not considered commercial gear. So why is a gig considered recreational gear?
If pray things change for the better for us in section e.
Frustrated in [redacted] beach
Jackie strickland
Thank you once again for listening and considering my concerns.

Sent from my Verizon, Samsung Galaxy smartphone

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From: Klibansky, Lara
To: Gillikin, Dana
Subject: FW: [External] Flounder regulation
Date: Thursday, August 27, 2020 6:15:35 AM

Lara K. J. Klibansky
Marine Fisheries Commission Liaison
Executive Assistant for Councils and Commissions
NC Division of Marine Fisheries
Department of Environmental Quality

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Lara.Klibansky@ncdenr.gov

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Morehead City, NC 28557

From: Bizzell, Rob <r.bizzell.mfc@ncdenr.gov>
Sent: Wednesday, August 26, 2020 7:03 PM
To: Klibansky, Lara <Lara.Klibansky@ncdenr.gov>
Subject: Fwd: [External] Flounder regulation

For the books. Thanks, Rob
Get Outlook for iOS

From: revjackie [redacted]
Sent: Wednesday, August 26, 2020 6:40 PM
To: Bizzell, Rob
Subject: [External] Flounder regulation

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Thank you sir for a reply. But let's please be honest with one another. I understand that we need regulations. But we need regulations that are
Fair to all. Each commercial license holder should be entitled to a certain amount of poundage. But we all know that the trawlers and pound netters are responsible for approx. 75 percent of all of North Carolinas poundage. We are being punished in section e for the overfishing that is going on up north. I also dont understand why you guys opened recreational season ahead of commercial Season in section e. You also removed the per vessel recreational limit. The recreational giggers have 4 to 5 people on a boat leaving the dock with 20 fish and I cant even fish yet
Dont it make sense to let commercial giggers fish. Even if we have a set creel limit per trip. My license cost to much for you guys to not let me fish. Things need to be looked at by section. What works in one area might not work in another. Also all the inlets down south are filling up. More needs to be done to improve habitat. Thanks for your time but the laws are not fair for us as they stand. Thank you for considering my concerns.
Jack

Sent from my Verizon, Samsung Galaxy smartphone

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Mailing Address:
P.O. Box 27255
Raleigh, NC 27611-7255

Phone: (919) 814-0700
Fax: (919) 715-0135

Ethics & Lobbying Education

The following information applies to public servants, legislators, legislative employees, and ethics liaisons. For information on lobbying education and awareness presentations for lobbyists and lobbyist principals.

Mandatory Education. The N.C. State Board of Elections and Ethics Enforcement provides mandatory ethics and lobbying education for *public servants*, *legislators*, *legislative employees* and *ethics liaisons*. Topics covered include:

- Filing a Statement of Economic Interest ("SEI")
- Monitoring and avoiding conflicts of interest
- The gift ban and its exceptions
- Prohibition on use of public position for private gain
- Lobbying and how it affects individuals covered by the State Government Ethics Act

Ethics education is the primary way individuals subject to the State Government Ethics Act are made aware of their public duties and responsibilities as well as the consequences for violating the ethics laws.

Who Must Participate

- **Public Servants & Ethics Liaisons.** All public servants and ethics liaisons are required to attend a Commission-approved basic ethics and lobbying education presentation within six (6) months of the person's election appointment, or employment and attend a refresher presentation at least every two (2) years thereafter.

- **Legislators & Legislative Employees.** The Commission, jointly with the Legislative Ethics Committee, makes mandatory ethics education and lobbying presentations to all legislators within two (2) months of the legislator assuming his or her office. Legislative employees must also participate in ethics education within three (3) months of employment and attend a refresher at least every two (2) years.

- **Education Presentations & Schedule.** Ethics and lobbying education presentations for public servants and ethics liaisons are offered online and live at Raleigh-only and distance education sites. Completing an online presentation or attending a live session meets either the basic or refresher mandatory education requirements. Visit https://www.ncsbe.gov/Ethics/Education to access online and live training options.

  Ethics education for **legislators** is conducted in live sessions. Legislative employees may participate in ethics education online through the General Assembly.

- **Consequences for Failure to Attend.** Failure to attend an ethics and lobbying education presentation is a violation of the State Government Ethics Act and may result in the individual being recommended for removal from his or her public position or disciplined in his or her State job.

Contact Information

For education related questions, contact:
NC State Board of Elections and Ethics Enforcement
Phone: (919) 814-3600
E-mail: Education.Ethics@doa.nc.gov

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2020 STATEMENT OF ECONOMIC INTEREST REMINDERS:

Completed SEIs must be filed on or before April 15, 2020. If you have already filed a 2020 SEI, do not refile. The forms and instructions can be found at https://ethics.ncsbe.gov/sei/blankForm.aspx.

If you filed a 2019 SEI ***and*** you have had ***no changes*** since your 2019 filing, you may file a 2020 SEI No Change Form, located on the website.

You must file a 2020 Long Form if any of the following apply to you:

a. You filed a 2019 SEI **but** you have had changes since your 2019 filing;
b. You did not file a 2019 SEI; or
c. You are a first-time filer or have been appointed to a new or additional position/board.

This year, the State Board of Elections and Ethics Enforcement will roll out a new electronic process for filing SEIs. That electronic filing option will be available in **early February**.

You are encouraged to file your SEI electronically. However, if you want to file your SEIs before the updated electronic version is available, hard copies are available for filing now at the link above.

New commissioners will need to file a 2020 SEI; however, if you have not had any changes since you last filed, you can use the No Change Form, which is fairly easy to complete.

Please file by April 15th to avoid fines and other penalties.

SEI HELPFUL TIPS

1. PUBLIC RECORDS. The State Board of Elections and Ethics Enforcement (State Board) is required to collect and maintain disclosures from certain persons covered by the State Elections and Ethics Enforcement Act Government Ethics Act (Elections and Ethics Act). By law, the information requested is public record and available to the public upon request. As public records, Statements of Economic Interest (SEI) are available on the Commission's website. Personal contact information, however, is not.

2. CONTACT INFORMATION PAGE. The Contact Information page, which includes your personal contact information, will not be available on the Commission's website, but is a public **record.**

3. CHILDREN'S INITIALS. Only list minor children's INITIALS on the SEI. List each child's full legal name on the Confidential Unemancipated Children's Form. If you are filing electronically, the form will be generated at the end of the SEI from the information that you provided on your electronic SEI. The Confidential Form is not a public record, and the State Board will not make it available to the public.

4. READ EACH QUESTION CAREFULLY. Read each question carefully and pay close attention to the time periods in each question as they do vary.

5. ANSWER EACH QUESTION. It is important to answer each question, including all applicable subparts. Even if your answer is "no" or "not applicable," make certain you answer each question. Many of the questions have "yes" and "no" boxes to check for your convenience. Incomplete SEIs may cause delays and negatively impact your public service on a covered board or as an employee.

6. WHY ARE YOU FILING. You must list the complete name of the state board or state agency employer for which you are filing the SEI. Without this information, your SEI may be delayed and negatively impact your public service on a covered board or as an employee.

7. HOW TO FILE. The State Board strongly recommends electronical on-line filing as it is secure, allows easy information updates, and gives you access to your electronic SEIs previously filed. Filing your SEI on-line is easy, quick, convenient, and reduces the chance of reporting errors. Getting started is easy. Follow the simple steps to create your own account and get access today: https://EFILE.ncsbe.gov/ To file a paper version of the SEI, you must provide the State Board with a signed, original SEI form. Each SEI includes an "affirmation" and is a legally binding document. Faxed or emailed copies of your SEI CANNOT be accepted.

SEI Helpful Tips, continued

8. INCOME. List each source of income as requested on the SEI. The actual dollar amount is not required. Be sure to list your employer as a source of income in Question # 6 of the SEI.

9. READ CAREFULLY. Read each question carefully, as the Elections and Ethics Act requires that you disclose your financial holdings and obligations, personal property, and real property and may also include your knowledge of the holdings of both your immediate family and your extended family. “Immediate family” and “extended family” are defined terms in the Elections and Ethics Act, and those definitions are included with this document.

10. REFLECT. Think carefully about WHY you are filing, and whether it has any relationship to your position. Does your board or commission license or regulate you? For many of the boards, a subject matter expert like a licensee is needed. Answering “yes” does not prohibit your service on the board, and your perspective is valued.

11. MAKE A COPY. Make a copy of the SEI for your own records, and make a note in your calendar when you submit it, whether on-line or by mail or hand delivery. When you successfully submit your SEI electronically on-line, the final screen will provide a confirmation number and will be proof that you have satisfied your filing obligation. Please print the **confirmation screen for your records.**

12. ETHICS LIAISON. Contact your Ethics Liaison to assist you in your obligations under the Elections and Ethics Act. Your Ethics Liaison is good source of information about how to fill out your SEI.

13. ON-LINE HELP. The State Board has on-line resources to answer questions you may have about your SEI. For more information, please visit the State Board website which has education offerings.

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14. DEFINITIONS. As noted above, certain terms are defined in the Elections and Ethics Act ("immediate family"). These definitions may be helpful to you in completing your SEI. A complete list of all definitions used in the Elections and Ethics Act is available on the State Board's website, under "Ethics". Some of the more common ones are attached to this document.

15. YOUR INTERNET BROWSER. Consider using Internet Explorer or Chrome to submit your SEI. Some users have had trouble using other browsers. 16. WE ARE HERE TO HELP YOU. In addition to on-line resources and written materials, the State Board has expert staff ready to answer any questions you might have and assist you in completing and filing your SEI. Do not hesitate to contact us at sei@ncsbee.gov (919) 814-3600.

2021 Meeting Planning Calendar

January

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February

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March

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April

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June

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August

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September

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October

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November

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December

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- MFC
- ASMFC
- SAFMC
- MAFMC
- ASMFC/MAFMC Joint Meeting
- Southern Regional AC
- Northern Regional AC
- Finfish AC
- Habitat and Water Quality AC
- Shellfish/Crustacean AC
- State Holiday

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2020 Committee Assignments for Marine Fisheries Commissioners

08/05/2020

FINFISH ADVISORY COMMITTEE

Statutorily required standing committee comprised of commissioners and advisers that considers matters related to finfish.

Commissioners: Tom Roller – chair, Sam Romano – vice chair
DMF Staff Lead: Lee Paramore - lee.paramore@ncdenr.gov
Meeting Frequency: Can meet quarterly, depending on assignments from MFC

HABITAT AND WATER QUALITY ADVISORY COMMITTEE & COASTAL HABITAT PROTECTION PLAN STEERING COMMITTEE

Statutorily required standing committee comprised of commissioners and advisers that considers matters concerning habitat and water quality that may affect coastal fisheries resources.

Commissioners: Pete Kornegay – chair, Dr. Martin Posey – vice chair
DMF Staff Lead: Anne Deaton - anne.deaton@ncdenr.gov
Meeting Frequency: Committee can meet quarterly, depending on assignments from MFC. CHPP Steering Committee can meet a couple of times a year.

SHELLFISH/CRUSTACEAN ADVISORY COMMITTEE

Statutorily required standing committee comprised of commissioners and advisers that considers matters concerning oysters, clams, scallops and other molluscan shellfish, shrimp and crabs.

Commissioners: Sam Romano – chair, Pete Kornegay – co-vice chair, Dr. Martin Posey – co-vice chair
DMF Staff Lead: Tina Moore - tina.moore@ncdenr.gov
Meeting Frequency: Can meet quarterly, depending on assignments from MFC

CONSERVATION FUND COMMITTEE

Committee comprised of commissioners that makes recommendations to the MFC for administering funds to be used for marine and estuarine resources management, including education about the importance of conservation.

Commissioners: Sam Romano - chair, Tom Hendrickson and Robert McNeill
DMF Staff Lead: Randy Gregory - randy.gregory@ncdenr.gov
Meeting Frequency: Meets as needed

LAW ENFORCEMENT AND CIVIL PENALTY COMMITTEE

Statutorily required committee comprised of commissioners that makes final agency decisions on civil penalty remission requests.

Commissioners: Rob Bizzell - chair, Doug Cross and Tom Hendrickson
DMF Staff Lead: Col. Carter Witten – carter.witten@ncdenr.gov
Meeting Frequency: Meets as needed

COASTAL RECREATIONAL FISHING LICENSE ADVISORY COMMITTEE

Committee consisting of the three recreational seats and the science seat to provide the DMF advice on the projects and grants issued using Coastal Recreational Fishing License trust funds.

Commissioners: Pete Kornegay – chair, Rob Bizzell, Tom Roller, and Robert McNeill
DMF Staff Lead: Jamie Botinovch - jamie.botinovch@ncdenr.gov
Meeting Frequency: Meets as needed

NOMINATING COMMITTEE

Committee comprised of commissioners that makes recommendations to the MFC on at-large and obligatory nominees for the Mid- and South Atlantic Fishery Management Councils.

Commissioners: Robert McNeill – chair, Pete Kornegay, Tom Roller and Mike Blanton
DMF Staff Lead: Chris Batsavage - chris.batsavage@ncdenr.gov
Meeting Frequency: Typically meets once a year

STANDARD COMMERCIAL FISHING LICENSE ELIGIBILITY BOARD

Statutorily required three-person board consisting of DEQ, DMF and MFC designees who apply eligibility criteria to determine whether an applicant is eligible for a SCFL.

Commission Designee: Mike Blanton
DMF Staff Lead: Marine Patrol Capt. Garland Yopp – garland.yopp@ncdenr.gov
Meeting Frequency: Meets two to three times a year, could need to meet more often depending on volume of applications

N.C. COMMERCIAL FISHING RESOURCE FUND COMMITTEE

Committee comprised of commissioners that the commission has given authority to make funding decisions on projects to develop and support sustainable commercial fishing in the state.

Commissioners: Doug Cross – chair, Mike Blanton and Sam Romano
DMF Staff Lead: William Brantley – william.brantley@ncdenr.gov
Meeting Frequency: Meets two to three times a year

WRC/MFC JOINT COMMITTEE ON DELINEATION OF FISHING WATERS

Committee formed to help integrate the work of the two commissions as they fulfill their statutory responsibilities to jointly determine the boundaries that define North Carolina's Inland, Coastal and Joint Fishing Waters as the agencies go through a statutorily defined periodic review of existing rules.

MFC Commissioners: Rob Bizzell, Dr. Martin Posey and Pete Kornegay
DMF Staff Lead: Anne Deaton - anne.deaton@ncdenr.gov
Meeting Frequency: Meets as needed

SHELLFISH CULTIVATION LEASE REVIEW COMMITTEE

Three-member committee formed to hear appeals of decisions of the Secretary regarding shellfish cultivation leases issued under G.S. 113-202.

MFC Commissioners: Rob Bizzell
DMF Staff Lead: Jacob Boyd – jacob.boyd@ncdenr.gov
Meeting Frequency: Meets as needed

COASTAL HABITAT PROTECTION PLAN STEERING COMMITTEE

The CHPP Steering Committee, which consists of two commissioners from the Marine Fisheries, Coastal Management and Environmental Management commissions reviews and approves the plan, recommendations, and implementation actions.

MFC Commissioners: Dr. Martin Posey, Pete Kornegay
DMF Staff Lead: Anne Deaton – anne.deaton@ncdenr.gov
Meeting Frequency: Meets as needed

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COMMITTEE REPORTS

NOMINATING COMMITTEE

JOINT MEETING OF THE MFC CRFC &
FUNDING COMMITTEE FOR THE NC CFRF

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NOMINATING COMMITTEE

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ROY COOPER
Governor

MICHAEL S. REGAN
Secretary

STEPHEN W. MURPHEY
Director

Oct. 23, 2020

MEMORANDUM

TO: N.C. Marine Fisheries Commission

FROM: Chris Batsavage, Special Assistant for Councils

SUBJECT: South Atlantic Fishery Management Council At-Large Seat and Mid-Atlantic Fishery Management Council At-Large Seat Nominations for North Carolina

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Issue
The N.C. General Statutes require the Marine Fisheries Commission to approve nominees for federal fishery management council seats for the governor's consideration, and that the statutes allow the governor to consult with the commission regarding additions to the list of candidates. The governor must nominate no fewer than three individuals for a federal fishery management council seat.

Findings
The Marine Fisheries Commission's Nominating Committee forwarded the following individuals to the Marine Fisheries Commission for the South Atlantic Fishery Management Council At-Large Seat and the Mid-Atlantic Fishery Management Council At-Large Seat

South Atlantic Fishery Management Council At-Large Seat

- Jess Hawkins, retired fisheries manager, educator, and ecotour operator from Morehead City
- Chris Kimrey, charter boat captain from Morehead City
- Bob Lorenz, recreational angler and scuba diver from Wilmington
- Tom Roller, charter boat captain from Beaufort

Mid-Atlantic Fishery Management Council At-Large Seat

- Sara Winslow, retired fisheries biologist and manager from Hertford and the current N.C. at-large member on the Mid-Atlantic Fishery Management Council
- Anna Beckwith, guide service owner from Morehead City
- Bill Gorham, fishing lure manufacturer owner from Southern Shores

Action Needed
The commission needs to approve nominees for the N.C. South Atlantic Fishery Management Council At-Large Seat and the N.C. Mid-Atlantic Fishery Management Council At-Large Seat.

For more information, please refer to:

- The draft minutes from the Oct. 16, 2020 Nominating Committee Meeting
- The nominees' biographies

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ROY COOPER
Governor

MICHAEL S. REGAN
Secretary

STEPHEN W. MURPHEY
Director

MEMORANDUM

TO: N.C. Marine Fisheries Commission
MFC Nominating Committee

FROM: Chris Batsavage and Dana Gillikin
Division of Marine Fisheries, DEQ

DATE: Oct. 29, 2020

SUBJECT: Marine Fisheries Commission Nominating Committee Meeting Minutes

The N.C. Marine Fisheries Commission Nominating Committee met on Friday, Oct. 16, 2019 at 1:30 p.m. via webinar.

The following were in attendance:

Committee members: Robert McNeill, James (Pete) Kornegay, Mike Blanton, Tom Roller
Staff: Chris Batsavage, Lara Klibansky, Dana Gillikin
Public: Anna Beckwith

Chairman McNeill called the meeting to order. The agenda was approved without modification.

Motion by Pete Kornegay to approve the October 23, 2019 meeting minutes. Seconded by Mike Blanton.

Roll Call Vote			
Commissioner	**Aye**	**Nay**	**Abstain**
Mike Blanton	X		
James Kornegay	X		
Robert McNeill	X		
Tom Roller	X		

Motion passes unanimously.

Public comment
No public comment given at the meeting or received via email.

Review of N.C. General Statutes and federal Magnuson-Stevens Act requirements
Batsavage briefly reviewed the N.C. General Statutes pertaining to the selection of nominees for federal fishery management council seats. He stated that the N.C. Marine Fisheries Commission must approve a slate of candidates for the governor's consideration, and that the statutes allow the governor to consult with the commission regarding additions to the list of candidates. Batsavage also described the federal statutes and regulations pertaining to qualification of candidates and noted that the governor must submit

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a list of no less than three nominees for an appointment. The commission will review the list of candidates approved by the committee at its business meeting via webinar on Nov. 19-20, 2020.

Review and selection of candidates for the South Atlantic Fishery Management Council at-large appointment and the Mid-Atlantic Fishery Management Council at-large appointment

Batsavage reviewed the bios of the candidates for the South Atlantic Fishery Management Council at-large seat, briefly describing the background and qualifications of each: Jess Hawkins, Christopher (Chris) Kimrey, Robert (Bob) Lorenz, and Thomas (Tom) Roller.

Batsavage then reviewed the bios of the candidates for the Mid-Atlantic Fishery Management Council at-large seat, briefly describing the background and qualifications of each: Sara Winslow (incumbent), Anna Beckwith, and William (Bill) Gorham. Batsavage noted that Ms. Winslow is completing her second three-year term and is eligible for another three-year term.

After a brief discussion of the candidates, the committee made the following motions:

South Atlantic Fishery Management Council At-Large Seat

Motion by Pete Kornegay to forward the names of Christopher Kimrey, Robert Lorenz, and Thomas Roller to the Marine Fisheries Commission for consideration for the South Atlantic Fishery Management Council at-large seat. Seconded by Robert McNeill. Motion withdrawn.

Motion by Mike Blanton to forward the names of Christopher Kimrey, Robert Lorenz, Jess Hawkins, and Thomas Roller to the Marine Fisheries Commission for consideration for the South Atlantic Fishery Management Council at-large seat. Seconded by Robert McNeill.

Roll Call Vote			
Commissioner	**Aye**	**Nay**	**Abstain**
Mike Blanton	X		
James Kornegay			X
Robert McNeill	X		
Tom Roller			

Commissioner Roller recused himself. Motion passed.

Mid-Atlantic Fishery Management Council At-Large Seat

Motion by Mike Blanton to forward the names of Sara Winslow, Anna Beckwith, and William Gorham to the Marine Fisheries Commission for consideration for the Mid-Atlantic Fishery Management Council at-large seat. Seconded by Pete Kornegay.

Roll Call Vote			
Commissioner	**Aye**	**Nay**	**Abstain**
Mike Blanton	X		
James Kornegay	X		
Robert McNeill	X		
Tom Roller	X		

Motion passes unanimously.

Motion by Mike Blanton to adjourn. Seconded by Tom Roller.
Meeting adjourned.

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South Atlantic Council Candidates

Jess Hawkins Morehead City, NC

North Carolina Marine Fisheries Commission Nominating Committee:

I would be honored to be considered by the North Carolina Marine Fisheries Commission (MFC) to serve on the South Atlantic Fishery Management Council (SAFMC) in the upcoming at-large seat vacancy. I believe with my background and experience that I could serve effectively in that role representing North Carolina.

I have a Master of Science degree in biology and retired as a fisheries scientist with the NC Division of Marine Fisheries (DMF) in 2006 after 30 years of service. I have served as Chief of Fisheries Management (the main research/management section of DMF), studying and conserving both state and federally managed species. The last 12 years of my career I was the Executive Assistant to the Director, working as the liaison with the MFC, developing rules and policies for North Carolina with extensive stakeholder input (approximately 100 meetings per year with advisors and MFC members.) I became quite familiar with fisheries issues facing North Carolina, including management of species occurring in federal jurisdiction. I represented the state in numerous meetings during controversial and difficult circumstances and at all times tried to conduct myself professionally. I have also worked with many of the leading fisheries scientists in our state.

After retiring from DMF, I was honored by an appointment to the MFC from 2007-2009, serving in an at-large seat. I thoroughly enjoyed my tenure and am excited to potentially serve our state on another body dealing with fisheries governance. I also received the Governor’s Award of the Order of the Long Leaf Pine in 2006 and the Governor’s Award as Wildlife Conservationist of the Year in 1994.

Since my retirement I have served as an educator at the NC Aquarium, teaching the public about ecology and conservation. I also was privileged to be hired as an instructor of marine fisheries ecology at Duke Marine Laboratory for three years. I currently co-teach marine fisheries ecology at NC State CMAST facility and have done so for five years. These opportunities have allowed me to track conservation policies and actions of many fisheries issues impacting North Carolina. I have also consulted on scientifically based issues involving fisheries conservation for stakeholder groups.

Recreational fishing is my main hobby and something I am passionate about. I grew up on the coast of North Carolina and have recreationally fished all of my life, fishing from Dare to New Hanover counties, both inshore and offshore. I have recreationally fished for many of the species under the jurisdiction of the SAFMC.

I also am president and owner of Crystal Coast Ecotours, where I provide people the opportunity to experience the wonderful natural resources of North Carolina. I have successfully operated this business for the last 10 years and we are ranked as the top outdoor activity in Morehead City by reviewers. I know how regulations and circumstances can affect recreationally important businesses. I hold a Master’s Captain License from the US Coast Guard.

I would be honored to be considered for this opening. I have attached a resume with additional information.

Jess H. Hawkins III

South Atlantic Council Candidates

Mr. Christopher G. Kimrey, Morehead City, NC

Mr. Kimrey was enlisted in the United States Navy for 6 years and served as an electronics technician for 5 years, before being honorable discharged due to a service connected injury. He graduated with honors from Carteret Community College in 2003 with an Associates in Arts. He is a PADI Certified Rescue Diver and licensed U.S. Coast Guard Captain (OUPV).

Mr. Kimrey has owned and operated Custom Saltwater Taxidermy, creating replicas of fish for customers worldwide since 1997. For the past 15 years he has been a full-time saltwater fishing guide and owner and operator of Mount Maker Charters, based out of Atlantic Beach, NC. Mr. Kimrey has completed the first of 2 sessions of the Marine Resource Education Program with the Gulf of Maine Research Institute, and is scheduled to complete the 2nd session (currently on hold due to COVID-19).

Mr. Kimrey has been an active participant in several tagging projects with N.C. State University, and N.C. Division of Marine Fisheries, which included a 3 year acoustic tagging project of Cobia and a 5 year anchor tagging project with weak fish. He was an active participant in the software pilot program for the For-Hire South Atlantic Fishery Management Council Pilot Project. He has attended various public forums at the State and Federal level pertaining to Marine Fisheries.

Mr. Kimrey has a life-long history of recreational and commercial fishing and a vast knowledge of saltwater fisheries. His charter fishing trips target a wide variety of species from the back waters to the Gulf Stream, including species managed by the South Atlantic Fishery Management Council. Many years of following State and Federal fisheries management plans, while spending 200+ days annually on the water gives him a unique and unbiased desire to pursue the conservation of our fisheries.

South Atlantic Council Candidates

Robert J. Lorenz, Wilmington, NC

Mr. Lorenz is a graduate of Florida Institute of Technology, B.S. Marine Biology. He completed a 29-year career in the pharmaceutical industry that started in research and development and culminated in manufacturing management. He held technical and management positions within major companies and start-ups. He maintained a consulting practice in pharmaceutical technical operations and manufacturing controls from 1998-2005. Mr. Lorenz's career expertise was to develop and improve manufacturing and business processes. He assured that processes complied with federal regulations, particularly as enforced by FDA, DEA, OSHA, and EPA. His specialty was to fix manufacturing operations that were under regulatory and business stress, including those operating within consent decrees and US Justice Department actions.

Mr. Lorenz maintains a lifelong interest in saltwater fishing, fisheries management, and the environment. He engages in volunteer work and activism for good stewardship of the ocean and ocean resources. He strives to maintain appropriate and pragmatic consumptive use of fisheries resources for enhanced economic and social vitality, with sufficient conservation to maintain sustainable ocean fisheries. He is an avid saltwater recreational fisherman and scuba diver.

Mr. Lorenz is the current Vice Chairman of the South Atlantic Fisheries Management Council (SAFMC) Snapper/Grouper Advisory Panel. In 2016 he was invited and participated in the SAFMC Citizen Science Design Program Workshop. During 2017 and 2018 he served as co-chair for a SAFMC Citizen Science Action Team that developed a program to recruit, orient and retain volunteers for SAFMC sponsored Citizen Science projects. In March 2019 he was a presenter with the SAFMC delegation that presented the Council's Citizen Science program to a national symposium held in Raleigh, NC. He is a current member on the SAFMC's Citizen Science Operations Committee and participated in the Scamp Grouper study pilot project design.

He completed the Marine Resources Education Program Science and Management training modules in 2016. The program educates qualified citizens to better understand and participate in federal fisheries and within the regional fisheries management councils.

For North Carolina fisheries, Mr. Lorenz was Chairman of the NCDMF Sea Turtle Advisory Committee 2011 through 2015. He served on the NCDMF Southern Fishery Advisory Committee 2014 - 2016. He currently serves as a recreational fishing representative from NC on the ASMFC Bluefish Advisory Panel.

Mr. Lorenz was a volunteer on fisheries projects that included SAV surveys, water/seine sampling, and tank and specimen maintenance at the NC Aquarium at Fort Fisher. He worked as crew on a shrimp boat and pulled a beach seine commercial fishing while completing university studies in Florida.

Mr. Lorenz has interests in business and personal investing. He was President of the Investors Roundtable of Wilmington for 2014 and 2016, and a board of governors' member for 8 years. He is currently a mentor for the UNCW Center for Innovation and Entrepreneurship. He is an active member within a non-profit, Wilmington Renaissance, who's mission is to assist in identifying and obtaining economic development and quality of life opportunities within the Wilmington, NC geographic area.

Mr. Lorenz has been a Wilmington area and New Hanover County resident since 2003.

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South Atlantic Council Candidates

Mr. Thomas N. Roller

Mr. Roller is the owner and operator of Waterdog Guide Service. For the past 17 years, he has been a full-time nearshore and inshore light tackle and fly fishing guide operating along the Crystal Coast of North Carolina. Mr. Roller is a licensed U.S. Coast Guard captain with extensive knowledge of southeastern North Carolina's waterways, and spends over 200 days on the water annually with clients. Species managed by the South Atlantic Fishery Management Council, including Spanish and king mackerel, amberjack, and many snapper grouper complex species are important mainstays of his guiding business.

Mr. Roller is an active participant in fisheries management, attending meetings and providing input at the state, interstate, and federal levels. He is highly involved in the South Atlantic Fishery Management Council process and currently serves as a member of the Council's Cobia/Mackerel Advisory Panel and Systems Management Plan workgroup. In the past, he also served on the Citizen Science Advisory Panel as a member of the Education/Outreach Action Team. In addition, he has been a member of the Mid-Atlantic Fishery Management Council's Bluefish AP since 2015.

Mr. Roller is a strong advocate for informed involvement in the management process. In 2017 he completed the Gulf of Maine Research Institute's Marine Resource Education Program for the southeast region, participating in two in-depth workshops to advance his knowledge of fisheries science and management. He encourages students to learn about the fisheries management process and regularly serves as a guest speaker and informal mentor to graduate students in the marine science community. Mr. Roller also contributes on-the-water experience to support data collection for management and stock assessment. He volunteered as a field tester to refine the South Atlantic region's electronic for-hire logbook software, participates in multiple ongoing fish tagging and fin clip studies for the Division of Marine Fisheries, and has contributed to multiple university research studies.

Mr. Roller is also a longtime participant in North Carolina's state fisheries management process and served on the North Carolina Marine Fisheries Commission's Blue Crab and Southern Flounder Fishery Management Plan Advisory Committees from 2017-2020. In January 2020, Mr. Roller was appointed by Governor Roy Cooper to the North Carolina Marine Fisheries Commission in the Recreational Industry Seat.

Mr. Roller is a founding member of the American Saltwater Guides Association, a coastwide organization with the mission of promoting sustainable business through marine conservation. He currently serves as an executive board member representing the state of North Carolina, and serves on the organization's policy committee. He was previously a member of the Executive Board of the Coastal Conservation Association of North Carolina from 2014 to January 2020 and served on the organization's Fisheries Committee as chairman from February 2016 to 2018.
Mr. Roller received a B.A. in English and history from Duke University in 2003 and resides in Beaufort, North Carolina.

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Mid-Atlantic Council Candidates

Sara Elliott Winslow, Hertford, NC

Ms. Winslow graduated from Perquimans County High School in Hertford, NC in 1973. She received a BS Degree in Marine Biology from UNC-Wilmington in 1978. Ms. Winslow began her career with the NC Division of Marine Fisheries in January 1979 as a Marine Fisheries Technician II in the Northern District Office in Elizabeth City. She worked on anadromous species projects until May 1982 when she was promoted to Biologist I where she served as the Project leader for a Shad and River Herring Federal Aid Project until June 1986 when she was promoted to Biologist II. In 1988, Ms. Winslow was promoted to the Northern District Biologist Supervisor position. In that capacity, she was responsible for overseeing biological staff and projects in N.C. Division of Marine Fisheries offices located in Elizabeth City, Manteo and Columbia. In December 2000, Ms. Winslow was promoted to Northern District Manager position where she was responsible for all regional N.C. Division of Marine Fisheries projects/programs and served as staff lead for the Northeast Advisory Committee. She also served on the division's Rules Advisory Team, the Management Review Team and participated in numerous division and N.C. Marine Fisheries Commission meetings and activities until her retirement in February 2011.

Ms. Winslow served as Project Leader for Phase II Striped Bass stocking and tag returns from 1980 to 2009. She served as Project Leader on N. C. Shad and River Herring projects where she was responsible for field sampling, data analysis and preparing project reports. She was responsible for reviewing and commenting on habitat alteration and coastal development permits (N.C. Division of Coastal Area Management Act, N.C. Division of Water Quality, U.S. Army Corps of Engineers, etc.) for 23 years. During her career, she was involved with the development of several fishery management plans, including serving as the lead on the N.C. River Herring Fishery Management Plan, as well as co-lead and later mentor for the N.C. Estuarine Striped Bass Fishery Management Plan.

At the interstate level, Ms. Winslow served on Atlantic States Marine Fisheries Commission Technical Committees for Shad and River Herring, Striped Bass and the Striped Bass Tagging Committee. For 21 of 23 years, Ms. Winslow participated in the Cooperative Winter Tagging Cruise, a collaborative effort among the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the N.C. Division of Marine Fisheries and several other Atlantic coast states including Virginia, Maryland, Delaware and New Jersey. As a cruise participant, she was responsible for data collection and tagging striped bass, summer flounder, red drum, Atlantic sturgeon, spiny dogfish and horseshoe crabs.

Ms. Winslow currently serves on the N.C. Marine Fisheries Commission Finfish and Northern Regional (Chair) Advisory Committees. Ms. Winslow was appointed to the Mid-Atlantic Fishery Management Council (New York – North Carolina) in August 2015 – 2018 to represent North Carolina and has been re-appointed for her second term (August 2018 – 2021). In 2019/2020, she serves on the following Mid-Atlantic Council committees: Demersal and Coastal Migratory, Mackerel, Squid and Butterfish (Vice Chair), Ecosystem (Vice Chair), Bluefish and Executive. Ms. Winslow is currently serving as the Chair of the Mid-Atlantic Fishery Management Council's River Herring and Shad Committee. In the past, she also served on the Protected Resources and Highly Migratory Species committees.

Ms. Winslow is a member of the Hertford United Methodist Church. She sings in the Chancel Choir and serves as Vice Chair of the Trustees, Chair of the Endowment Committee and Chair of the Scholarship Committee.

Ms. Winslow is a past President of the Perquimans County Jaycees, Top 10 Local Presidents of North Carolina Jaycees and past Chaplain of the North Carolina Jaycees. In 2012, she was awarded the North Carolina Order of the Long Leaf Pine award.

Currently, serves as Co-Chair of the Citizens for the Preservation of Hertford, currently membership of 80+ town and county residents.

Her hobbies are salt and freshwater fishing, hunting and gardening.

Mid-Atlantic Council Candidates

Mrs. Anna Beckwith, Morehead City, NC.

Mrs. Beckwith holds a B.S. degree in Environmental Science and Policy from Florida International University in Miami, FL and a M.S. degree in Biological Oceanography with a Minor in Geographic Information Science from N.C. State University in Raleigh, NC.

Mrs. Beckwith is currently finishing her third term on the South Atlantic Fishery Management Council. Her current term ends August 2021. On the SAFMC she serves as an at-large seat and is chair of the Dolphin/Wahoo, and Highly Migratory Species (HMS) Committees. As Chair of the HMS Committee she also serves on the HMS Advisory Panel for the National Marine Fisheries Service and the ICCAT Advisory Committee. She attended the International Commission for the Conservation of Atlantic Tunas (ICCAT) 2014, 2015 and 2016 annual meeting as part of the U.S. delegation. Mrs. Beckwith has also served as liaison to the Gulf of Mexico Fishery Management Council and the Mid Atlantic Fishery Management Council on numerous occasions. Mrs. Beckwith has also served as a Council representative on King Mackerel, Cobia, Blueline Tilefish and Red Snapper (currently on going) stock assessments

Mrs. Beckwith served on the N.C. Marine Fisheries Commission from 2009 to 2015, serving as Vice-Chair from 2011 to 2015.

Mrs. Beckwith and her husband own Down East Guide Service, a North Carolina recreational fishing guide service and international travel agency for sport fisherman specializing in Costa Rica and Argentina. They are the managing partners of Dragin Fly Sportfishing based out of Los Suenos Marina Costa Rica.

Prior to 2007 Mrs. Beckwith taught Environmental Science and Biology at the high school level and sixth, seventh and eighth grade science in eastern North Carolina. She was a research consultant (post-graduate work) from 2004 through 2006 monitoring red drum spawning habitat using passive acoustics, water quality, and egg/larval monitoring in the Neuse River Estuary, Pamlico River, Pamlico Sound and Ocracoke Inlet.

Previous to pursuing her graduate degree Mrs. Beckwith was employed as Program Manager (1999-2001) for the American Farmland Trust in Washington, DC and was a marine fellow for The Nature Conservancy (1999).

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Mid-Atlantic Council Candidates

William Gorham, Southern Shores, NC

Mr. Gorham is owner of Bowed Up Lures, a fishing lure manufacturer located in Dare County. Given Mr. Gorham's market area for his lure company, it gives him great insight into fisheries in both the Atlantic and Gulf states.

Mr. Gorham has been involved in the state and federal fisheries management for a number of years. He currently serves as the ongoing proxy for North Carolina’s Legislative Appointee on the Atlantic States Marine Fisheries Commission. Mr. Gorham also served on the South Atlantic's Cobia sub panel and Citizen Science Advisory Committee.

Mr. Gorham was also appointed to participate in each step of SEDAR 58 cobia stock assessment.

Mr. Gorham has also assisted in stakeholder outreach and education on a variety of regulatory proposals.

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JOINT MEETING
OF THE MFC COMMERCIAL RESOURCES FUND COMMITTEE & THE FUNDING COMMITTEE FOR THE N. C. COMMERCIAL FISHING RESOURCE FUND

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ROY COOPER
Governor

MICHAEL S. REGAN
Secretary

STEPHEN W. MURPHEY
Director

October 28, 2020

MEMORANDUM

TO: N.C. Marine Fisheries Commission

FROM: William Brantley, Grants Program Manager, Administrative and Maintenance Services Section

SUBJECT: July 30, 2020 Commercial Fishing Resource Fund Committee Meeting

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Issue
The N.C. Commercial Fishing Resource Funding Committee met jointly with the N.C. Marine Fisheries Commission Commercial Fishing Resource Fund Committee at 2:30 p.m. on Thursday, July 30, 2020 on WebEx to review and vote on re-publishing their Public Relations Request for Proposals (RFP).

Findings
The joint committees reviewed and approved re-publishing an RFP for the continuation of a public relations campaign.

1. **Public Relations Campaign** – This request for proposals is to continue a campaign to educate the public about North Carolina's sustainable commercial fishing industry and about commercial fishermen participation in research and measures the industry has taken to reduce its environmental impact.

Action Needed.
For informational purposes only, **no action is needed at this time.**

For more information, please refer to the CFRF Meeting Minutes in this briefing book.

State of North Carolina | Division of Marine Fisheries
3441 Arendell Street | P.O. Box 769 | Morehead City, North Carolina 28557
252-726-7021

ROY COOPER
Governor

MICHAEL S. REGAN
Secretary

STEPHEN W. MURPHEY
Director

MEMORANDUM

TO: N.C. Marine Fisheries Commission Commercial Resource Fund Committee and the Funding Committee for the N.C. Commercial Fishing Resource Fund

FROM: William Brantley, Grants Program Manager
Division of Marine Fisheries, NCDEQ

DATE: August 5, 2020

SUBJECT: MFC Commercial Resource Fund Committee and Funding Committee for the N.C. Commercial Fishing Resource Fund Meeting Minutes

The MFC Commercial Resource Fund Committee and the Funding Committee for the N.C. Commercial Fishing Resource Fund met at 2:30 p.m. on Thursday, July 30, 2020 through Webex. The following attended:

MFC Commercial Resource Fund Committee: Chairman Doug Cross, Sam Romano, Mike Blanton

Funding Committee for the N.C. Commercial Fishing Resource Fund Members: Chairman Ernest Doshier, Glenn Skinner, Steve Weeks, Gilbert Baccus, and Doug Todd

Absent: Britton Shackleford

Public Comment: Public comment was received through webpage and US mail

APPROVAL OF AGENDA AND MINUTES

Chairman Ernest Doshier called the meeting to order for the Funding Committee for the N.C. Commercial Fishing Resource Fund. Chairman Doshier asked Brantley to read the conflict of interest reminder, then inquired to any conflicts of interest. None were noted. Chairman Doug Cross called the meeting to order for the MFC Commercial Resource Fund Committee and inquired to any conflicts of interest. None were noted. Brantley conducted a roll call, all members were present with the exception of Shackleford.

The meeting agenda was then reviewed.
Chairman Cross approved the agenda, along with Romano and Blanton.

Chairman Doshier asked for approval of the agenda. All members present voiced approval.

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Minutes from the June 30, 2020 MFC Commercial Resource Fund (CRF) Committee meeting and the Funding Committee for the N.C. Commercial Fishing Resource Fund were reviewed.

Romano made a motion to approve the minutes, with a second from Blanton. Motion passed unanimously through roll call vote.

Weeks made a motion to approve the minutes. Todd seconded the motion. Motion passed unanimously through roll call vote of present members.

Brantley briefed the committees on points from Session Law 2020-3 and read into the minute's options for the committees to consider as they seek to approve a six-month project extension for the NC Commercial Fishing Public Relations campaign. Brantley also noted that public comment had been received prior to the meeting and copies had been sent to members. This included one comment through the webpage, and one comment through email that had a photo attachment.

CFRF REQUEST FOR PROPOSALS (RFP) REVIEW

Public Relations Campaign

Chairmen Cross and Doshier asked for members to review a statement of work and proposal for continuation of the CFRF Public Relations (PR) campaign which was sent to the Committees due to an approved motion to request a proposal and statement of work for a 6-month extension of the current contract with 50% of the budget from 2020 under the current guidelines.

Motion by Romano to approve the six-month extension and statement of work, with a second from Blanton. Motion passed unanimously through roll call vote.

Weeks made a motion to approve the contract extension as proposed by SA Cherokee, LLC and Blue Red Marketing, with a second by Skinner. Motion passed unanimously through roll call vote of present members.

COMMITTEE MEMBER ISSUES

FY21 RFP Status

Skinner stated that the Committees did not receive any proposals for the Public Relations RFP, and that the firm that had conducted the campaign in the past did not realize there was a RFP opportunity. Weeks asked if two weeks was a sufficient time to publish the RFP. Blanton asked about the status of applications. Brantley stated that the Committees received six proposals that targeted water quality, one proposal did not state a target, and one that targeted diamondback terrapin. Blanton asked for discussion opening both RFP's for an additional two weeks.

Motion by Skinner that we repost the PR RFP for an additional two weeks as soon as possible, with a second by Weeks. Motion passed unanimously through roll call vote of present members.

Motion by Romano to mirror the motion of the funding committee, with a second by Blanton. **Motion passed unanimously through roll call vote.**

Public Relations External Usage
Skinner asked that in a future meeting, the Committees jointly discuss usage of the material from the Public Relations campaign. He stated that he would like to see a process put into place for other groups or media outlets to use the campaign material.

Proposal Review Schedule
Blanton stated concerns over the Crab Pot Cleanup proposal, and if approved, would they have time to get the contract approved for a January start. Brantley stated that they could try to keep the administrative pieces moving for a January start. Blanton stated he would like the Chairmen to consider hearing this proposal separately if their next meeting was going to be pushed into September/October.

Adjournment
Motion by Romano to adjourn. Second by Blanton. Motion passed unanimously through roll call vote.

Motion by Skinner to adjourn. Second by Todd. Motion passed unanimously through roll call vote of present members.

Meeting adjourned at 3:33 p.m.

WB

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October 28, 2020

MEMORANDUM

TO: N.C. Marine Fisheries Commission

FROM: William Brantley, Grants Program Manager, Administrative and Maintenance Services Section

SUBJECT: October 27, 2020 Commercial Fishing Resource Fund Committee Meeting

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Issue
The N.C. Commercial Fishing Resource Funding Committee met jointly with the N.C. Marine Fisheries Commission Commercial Fishing Resource Fund Committee at 1:30 p.m. on Tuesday, October 27, 2020 on Webex to review and vote on funding opportunities from their Comprehensive and Public Relations request for proposals (RFP).

Findings
The joint committees reviewed and approved one proposal from the Diamondback Terrapin objective and four proposals from the Water Quality objective. Two proposals from the Public Relations RFP are pending conditional approval.

Meeting minutes are being drafted and will be provided during the February 2021 MFC meeting.

Action Needed.
For informational purposes only, **no action is needed at this time.**

State of North Carolina | Division of Marine Fisheries
3441 Arendell Street | P.O. Box 769 | Morehead City, North Carolina 28557
252-726-7021

DIRECTOR'S REPORTS

ASMFC

MAFMC

SAFMC

HMS

PROTECTED RESOURCES UPDATE

LANDINGS UPDATE

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ASMFC

Atlantic States Marine Fisheries Commission

79th Annual Meeting Webinar Summary

Sustainable and Cooperative Management of Atlantic Coastal Fisheries

79th Annual Meeting Webinar
October 19-22, 2020

Toni Kerns, ISFMP, or
Tina Berger, Communications
For more information, please contact
the identified individual at
703.842.0740

Meeting Summaries, Press Releases and Motions

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ATLANTIC HERRING MANAGEMENT BOARD (OCTOBER 19, 2020)

Meeting Summary

The Atlantic Herring Management Board reviewed the 2021-2023 fishery specifications package which was approved by the New England Fishery Management Council (Council) through Framework 8. The Framework proposes a lower sub-annual catch limit (ACL) for Area 1A in 2021 (1,391 mt) and 2022/2023 (1,184 mt) based on results of the 2020 Management Track Assessment and following the acceptable biological catch ABC control rule proposed in Amendment 8. The Framework also proposes changes to the 2,000-pound incidental catch limit for Atlantic herring in Areas 2 and 3 to aid the mackerel fishery in better utilizing its available quota when the herring quota is low. This and other decision points in Framework 8, such as the management uncertainty buffer, transfers for at-sea processing, carryover of unused quota, and the research set aside, were informed by recommendations from the Council's Scientific and Statistical Committee, Advisory Panel, and Herring Committee.

Framework 8 was submitted to NOAA Fisheries for review in September. Similar to previous years, the Board decided to wait until a final rule is released by NOAA Fisheries before it considers specifications for the Area 1A fishery in 2021 (and beyond). However, the Board did approve a seasonal quota allocation for the 2021 Area 1A fishery with 72.8% available from June through September and 27.2% allocated from October through December, which is consistent with the seasonal allocation strategy set for the Area 1A fishery in 2020. Additionally, the fishery will close when 92% of the seasonal period's quota has been projected to be harvested and underages from June through September shall be rolled into the October through December period.

Lastly, the Board received an update regarding ongoing discussions between Commission and Council leadership on better coordinating state and federal herring management. A proposed list of shared management responsibilities, developed by a work group of Commission Plan Review Team and Council Fishery Management Action Team members, was reviewed by Commission and Council leadership. While no action was taken at their last meeting, leadership agreed to continue to discuss how best to cooperatively manage the herring resource and fishery. Another update will be provided to the Board in February.

For more information, please contact Max Appelman, Fishery Management Plan Coordinator, at mappelman@asmfc.org or 703.842.0740.

Motions

Move to allocate the 2021 Area 1A sub-ACL seasonally with 72.8% available from June through September and 27.2% allocated from October through December. The fishery will close when 92% of the seasonal period's quota has been projected to be harvested and underages from June through September shall be rolled into the October through December period.

Motion made by Ms. Ware and seconded by Mr. Kane. Motion approved by consent (Roll Call: in favor – ME, NH, MA, RI, CT, NY, NJ, NEFMC, NMFS)

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WINTER FLOUNDER MANAGEMENT BOARD (OCTOBER 19, 2020)

Meeting Summary

The Winter Flounder Management Board reviewed the 2020 assessment updates for the Gulf of Maine (GOM) and Southern New England Mid-Atlantic (SNE/MA) winter flounder stocks. The stock assessment reports were peer-reviewed in September as part of the Northeast Fisheries Science Center's 2020 Management Track Stock Assessment process.

The GOM stock assessment indicates overfishing was not occurring in 2019. The assessment produces biomass estimates from three different fall surveys, but the area-swept methodology does not provide biomass reference points, resulting in an unknown stock biomass status. The GOM survey indices of abundance are relatively flat over the full time series with little change to the size structure. The Board expressed concern that these indices of winter flounder abundance have not demonstrated any response to the large declines in commercial and recreational removals since the 1980s. It was suggested that research is needed to better understand winter flounder abundance and distribution within different habitat types and especially estuaries for future stock assessments.

The SNE/MA assessment indicates the stock is overfished but overfishing did not occur in 2019. The spawning stock biomass estimate reached a time series low in 2019 of 64% of the biomass threshold despite sustained low levels of fishing mortality. Recruitment, an important indicator of the stock's ability to rebuild, has declined sharply since the 1980s and remains near the time series low. The Board expressed concern over the SNE/MA's depleted stock status and the low probability of rebuilding to the biomass target by 2023, the rebuilding plan target date. The Board emphasized the importance of incorporating environmental indicators into future stock assessments to better capture the influence of climate change on the stock's ability to rebuild.

In December, the New England Fishery Management Council will recommend specifications to NOAA Fisheries based on the 2020 assessment results and recommendations from its Scientific and Statistical Committee. After reviewing the Council's recommendation to NOAA, the Board will set state water specifications in February.

For more information, please contact Dustin Colson Leaning, Fishery Management Plan Coordinator, at dleaning@asmfc.org.

Motions

Move to nominate William Hyatt as the Vice-chair to the Winter Flounder Management Board.
Motion made by Ms. Ware and seconded by Ms. Patterson. Motion stands approved.

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Press Release

American Lobster Benchmark Stock Assessment Finds GOM/GBK Stock Not Overfished nor Experiencing Overfishing & SNE Stock Significantly Depleted

Assessment Introduces Regime Shift Methodology to Address Changing Environmental Conditions

The 2020 American Lobster Benchmark Stock Assessment presents contrasting results for the two American lobster stock units, with record high abundance and recruitment in the Gulf of Maine and Georges Bank stock (GOM/GBK) and record low abundance and recruitment in the Southern New England stock (SNE) in recent years. The GOM/GBK stock is not overfished nor experiencing overfishing. Conversely, the SNE stock is significantly depleted with poor prospects of recovery. Stock status was assessed using the University of Maine Stock Assessment Model for American Lobster (UMM, Chen et al. 2005), a statistical catch-at-length model that tracks the population of lobster by sex, size and season over time.

"On behalf of the American Lobster Board, I want to applaud the members of the Technical Committee and Stock Assessment Subcommittee for their exceptional work on the 2020 Benchmark Stock Assessment Report," stated Board Chair Dan McKiernan from Massachusetts. "This assessment made a notable advancement in considering the impact of changing environmental conditions on lobster population dynamics."

Extensive research has highlighted the influence of the environment on American lobster life history and population dynamics. Among the critical environmental variables, temperature stands out as the primary influence. Further, its range is experiencing changing environmental conditions at some of the fastest rates in the world. Therefore, considering these environmental influences is vital when assessing the lobster stocks and was a focal point of this stock assessment. Environmental data time series included water temperatures at several fixed monitoring stations throughout the lobster's range, average water temperatures over large areas such as those sampled by fishery-independent surveys, oceanographic processes affecting the environment, and other environmental indicators such as lobster prey abundance.

Environmental time series were analyzed for regime shifts, which indicate a significant difference in the lobster's environment and population dynamics from one time period to another. Regime shifts can change a stock's productivity, impacting the stock's level of recruitment and its ability to support different levels of catch. Temperature time series were also analyzed to quantify the effect of temperature on survey catchability of lobster and correct trends in abundance estimated from surveys by accounting for temperature-driven changes in catchability through time.

Model-estimated abundance time series were also analyzed for shifts that may be attributed to changing environmental conditions and new baselines for stock productivity. Shifts were detected for the GOM/GBK stock in 1996 and 2009 and one shift was detected for the SNE stock in 2003. The GOM/GBK stock shifted from a low abundance regime during the early 1980s through 1995 to a moderate abundance regime during 1996-2008, and shifted once again to a high abundance regime during 2009-2018 (Figure 1). Conversely, the SNE stock shifted from a high abundance regime during

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the early 1980s through 2002 to a low abundance regime during 2003-2018 (Figure 2). New reference points were developed to account for the changing regimes.

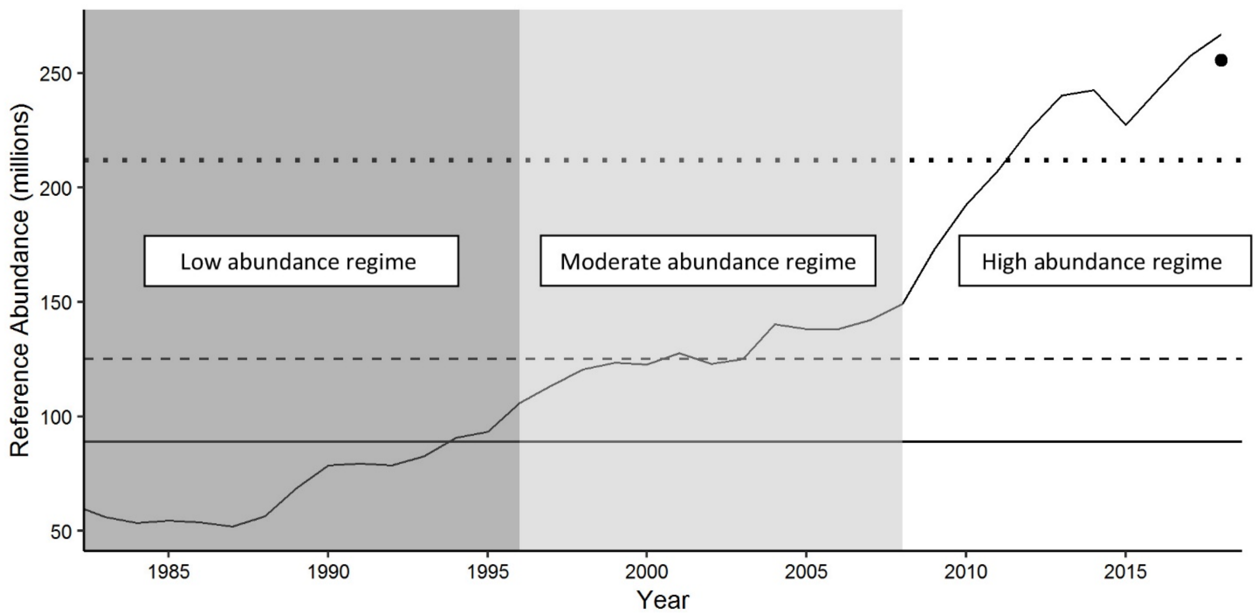

Figure 1. GOM/GBK stock abundance compared to the fishery/industry target (dotted black line), abundance limit (dashed black line), and abundance threshold (solid black line) reference points based on detected low (dark grey period), moderate (light grey period), and high (white period) abundance regimes. The circle is the three-year (2016-2018) average reference abundance.

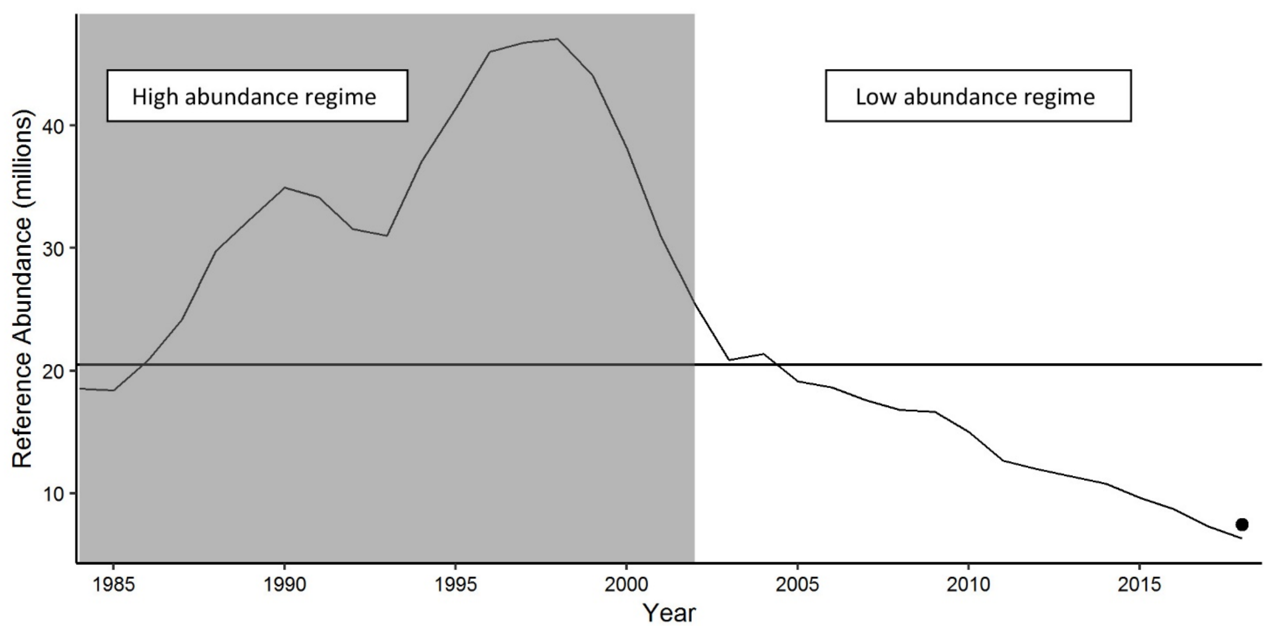

Figure 2. SNE stock abundance compared to the abundance threshold (solid black line) reference point based on detected high (grey period) and low (white period) abundance regimes. The circle is the three-year (2016-2018) average reference abundance.

In this assessment, three reference points are used to characterize stock abundance. The **abundance threshold** is calculated as the average of the three highest abundance years during the low abundance regime. A stock abundance level below this threshold is considered significantly depleted and in danger of stock collapse. This was the only abundance reference point recommended for the SNE stock due to

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its record low abundance and low likelihood of reaching this threshold in the near future. The **abundance limit** is calculated as the median abundance during the moderate abundance regime. Stock abundance that falls below this limit is considered depleted because the stock's ability to replenish itself is diminished. The **fishery/industry target** is calculated as the 25th percentile of the abundance during the high abundance regime. In this case, when abundance falls below this target, the stock's ability to replenish itself is not jeopardized, but it may indicate a degrading of economic conditions for the lobster fishery.

Two reference points are used to evaluate the fishing mortality condition of the stocks. The **exploitation threshold** is calculated as the 75th percentile of exploitation during the current abundance regime. The stock is considered to be experiencing overfishing if exploitation exceeds the exploitation threshold. The **exploitation target** is calculated as the 25th percentile of exploitation during the current abundance regime.

Based on these reference points, the GOM/GBK stock is not depleted and overfishing is not occurring. The average abundance from 2016-2018 was 256 million lobster which is greater than the fishery/industry target of 212 million lobster. The average exploitation from 2016-2018 was 0.459, below the exploitation target of 0.461.

The SNE stock is significantly depleted and overfishing is not occurring. The average abundance from 2016-2018 was 7 million lobster, well below the abundance threshold of 20 million lobster. The average exploitation from 2016-2018 was 0.274, falling between the exploitation threshold of 0.290 and the exploitation target of 0.257.

Stock indicators were also used as an independent, model-free assessment of the lobster stocks. These indicators are based strictly on observed data and are free from inherent assumptions in the population dynamics models. GOM/GBK stock indicators showed similar results to the assessment model, with increasing abundance and distribution of recruits and larger-sized lobster over time. However, abundances of young-of-year (YOY) lobster have been negative or neutral since the 2015 stock assessment and YOY abundance appears particularly poor in the southwestern areas of the stock. Recent research has indicated lobster larvae may be settling in habitat outside that covered by current surveys, but these trends are concerning and need to be further researched. Exploitation generally declined through time to its lowest levels in recent years. Fishery performance indicators were generally positive in recent years with several shifting into positive conditions around 2010. New stress indicators were developed for this assessment, including shell disease prevalence and the number of annual days with temperature equal to or above 20° C. These indicators show relatively low stress, but indicate some increasingly stressful conditions through time, particularly in the southwest portion of the stock.

Indicators for the SNE stock also showed similar results to the assessment model, with decreasing abundance and distribution of all life stages to low levels in recent years. All indicators averaged below their time series medians since the 2015 assessment and many have averaged below the 25th percentile. Mortality indicators based on exploitation rates were variable across surveys, and fishery performance indicators have generally shown deteriorating performance in recent years. The stress indicators point toward similar negative conditions in the stock's environment, including unfavorably warm waters and the manifestation of a stressful environment through high shell disease prevalence.

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Combined, these indicators reflect the SNE stock's very poor condition and continuing recruitment failure.

The American Lobster Board accepted the Benchmark Stock Assessment and Peer Review Report for management use, adopted the new reference points as recommended by the assessment, and committed to considering management responses to the assessment findings at its next meeting in February 2021. In addition, the Board intends to continue development of Addendum XXVII, which was initiated in 2017 to proactively increase resilience of the GOM/GBK stock but stalled due to the prioritization of Atlantic right whale issues.

A more detailed overview of the stock assessment, as well as the Benchmark Stock Assessment will be available on the Commission website, www.asmfc.org, on the American Lobster webpage under stock assessment reports. For more information, please contact Caitlin Starks, Fishery Management Coordinator, at cstarks@asmfc.org or 703.842.0740.

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PR20-22

Meeting Summary

After reviewing and accepting the 2020 American Lobster Benchmark Stock Assessment and Peer Review for management use, the American Lobster Management Board considered several additional items: a report on data collection requirements for 2021, a report on the electronic tracking pilot program, and the annual Fishery Management Reviews (FMP) for Lobster and Jonah crab.

Staff provided a report on the data collection requirements under Addendum XXVI for which implementation had been delayed from January 1, 2019 to January 1, 2021 in order to incorporate the elements into all reporting platforms. Over the past several months, a Lobster Data Elements Work Group has met weekly to develop definitions for the remaining data elements to ensure consistency in state and federal lobster-only reporting. Specifically, the Work Group recommended changes to federal collection of five effort level and gear characterization data points after the lobster-only permit holders begin reporting via federal VTRs. These include number of trap hauls, number of traps in the water by area, traps per trawl hauled, number of buoy lines by area, and total number of buoy lines. The Board forwarded a recommendation to the Interstate Fishery Management Program Policy Board to send a letter to NOAA Fisheries requesting these changes to VTRs; if accepted, it may be one to two years until implementation.

Next, the Board received a presentation on the results of the electronic tracking pilot program, which was initiated through Addendum XXVI. The project assessed tracking devices from Succorfish, Rock7, and Pelagic Data Systems by placing them on volunteer lobster vessels from Maine and Massachusetts with federal lobster permits from June 2019 to May 2020. Though the devices differed somewhat in features and performance, they all were able to deliver vessel positions and detect individual trap hauls. Cellular based systems were both lower in cost and permitted faster ping rates than satellite systems. Recognizing the critical need for electronic tracking to characterize spatial and temporal effort of the lobster fishery, the Board supported an expanded pilot project and future work on data integration and hardware testing. The Board Chair and several other members volunteered to produce a white paper describing the need for this information, which will be presented at the next meeting.

Finally, the Board considered the American Lobster FMP Review for the 2019 fishing year, and the Jonah Crab FMP Reviews for the 2018 and 2019 fishing years. No management concerns were raised for lobster, however, for the past three years New York has been unable to implement two required measures for Jonah crab: regulations to limit the directed trap fishery to lobster permit holders only, and the 1,000 crab bycatch limit for non-trap and non-lobster trap gear. The Board approved the FMP Reviews, state compliance reports, and *de minimis* requests for both species, and also made a recommendation to the ISFMP Policy Board to send a letter to New York regarding its implementation of Jonah crab measures.

For more information, please contact Caitlin Starks, Fishery Management Plan Coordinator, at cstarks@asmfc.org or 703.842.0740.

Motions

Move to accept the 2020 American Lobster Benchmark Stock Assessment and Peer Review for management use.

Motion made by Mr. Borden and seconded by Mr. Keliher. Motion passes by unanimous consent.

Move to adopt the following reference points as recommended in the 2020 benchmark assessment for the GOM/GBK stock:

- **Abundance reference points: Fishery/industry Target, Abundance Limit, and Abundance Threshold (212 million lobsters, 125 million lobsters, and 89 million lobsters, respectively)**
- **Exploitation Reference Points: exploitation threshold and exploitation target (75th and 25th percentiles of annual exploitation estimates during the current abundance regime)**
- **And for the SNE stock:**
- **Abundance Threshold for the SNE stock (20 million lobsters)**
- **Exploitation Reference Points: exploitation threshold and exploitation target (75th and 25th percentiles of annual exploitation estimates during the current abundance regime)**

Motion made by Dr. McNamee and seconded by Mr. Kane. Motion adopted by unanimous consent.

Move to recommend to the ISFMP Policy Board a letter be sent to New York regarding the implementation of Jonah crab measures.

Motion made by Mr. Keliher and seconded by Mr. Borden. Motion passes by unanimous consent, with one abstention from New York.

Move to approve the Lobster FMP Review for the 2019 fishing year, state compliance reports, and *de minimis* status for DE, MD, and VA.

Motion made by Ms. Patterson and seconded by Mr. Kane. Motion passes by unanimous consent.

Move to approve the Jonah Crab FMP Reviews for the 2018 and 2019 fishing years, state compliance reports, and *de minimis* status for DE, MD, and VA.

Motion made by Ms. Patterson and seconded by Mr. Borden. Motion adopted by consent.

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ATLANTIC MENHADEN MANAGEMENT BOARD (OCTOBER 20, 2020)

Press Release

ASMFC Atlantic Menhaden Board Approves TAC for 2021-2022

The Atlantic Menhaden Management Board (Board) approved a total allowable catch (TAC) of 194,400 metric tons (mt) for the 2021 and 2022 fishing seasons, which represents a 10% reduction from the 2018-2020 TAC level. The 2021-2022 TAC was set based on the ecological reference points (ERPs) approved by the Board in August, and reaffirms the Board's commitment to manage the fishery in a way that accounts for the species role as a forage fish.

"This TAC represents a measured and deliberate way for this Board to move into the realm of ecosystem-based management," said Chair Spud Woodward of Georgia. "The TAC strikes a balance between stakeholder interests to maintain harvest on menhaden at recent levels, while also allowing the ERP models to do what they are intended to do."

Based on projections, the TAC is estimated to have a 58.5% and 52.5% probability of exceeding the ERP fishing mortality (*F*) target in the first and second year, respectively. The TAC will be made available to the states based on the state-by-state allocation established by Amendment 3 (see accompanying table for 2021 and 2022 based on a TAC of 194,400 mt).

In determining which level to set the TAC, the Board also considered recent updates to the fecundity (*FEC*) reference points, and current stock condition. According to the latest assessment results, the 2017 estimate of fecundity, a measure of reproductive potential, was above both the ERP *FEC* target and threshold, indicating the stock was not overfished. A stock assessment update is scheduled for 2022 which will inform the TAC for 2023 and beyond.

2021-2022 ATLANTIC MENHADEN QUOTAS

		Metric Tons	Pounds
TAC		194,400	428,578,637
1% Set Aside*		1,944	4,285,786
TAC After Set Aside		192,456	424,292,851
STATE	**ALLOCATION**	**QUOTA (MT)**	**QUOTA (LBS)**
ME	0.52%	995	2,194,080
NH	0.50%	962	2,121,582
MA	1.27%	2,453	5,407,708
RI	0.52%	996	2,196,488
CT	0.52%	993	2,188,342
NY	0.69%	1,330	2,931,091
NJ	10.87%	20,925	46,131,966
PA	0.50%	962	2,121,464
DE	0.51%	986	2,174,821
MD	1.89%	3,634	8,011,402
PRFC	1.07%	2,066	4,554,267
VA	78.66%	151,392	333,761,875
NC	0.96%	1,840	4,056,588
SC	0.50%	962	2,121,464
GA	0.50%	962	2,121,464
FL	0.52%	997	2,198,250
TOTAL	100%	192,456	424,292,851

*1% of the TAC is set aside for episodic events, the remaining TAC is allocated to the states per the provisions of Amendment 3. Quotas may be adjusted pending final 2020 landings and the redistribution of any relinquished quota.

For more information, please contact Max Appelman, Fishery Management Plan Coordinator, or Toni Kerns, ISFMP Director, at mappelman@asmfc.org or tkerns@asmfc.org, respectively.

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Motions

Move to approve the Ecological Reference Point (ERP) fecundity target and threshold, which correspond with the fishing mortality (*F*) ERPs approved in August 2020, for the management of Atlantic menhaden. The ERP fecundity target and threshold are to be defined as the equilibrium fecundity that results when the Atlantic menhaden population is fished at the ERP *F* target and threshold respectively.

Motion made by Ms. Fegley and seconded by Mr. Rhodes. Motion carries without objection.

Main Motion

Move to set the total allowable catch (TAC) at 176,800 metric tons for 2021 and 187,400 metric tons for 2022 which are the levels associated with a 50% probability of exceeding the ERP fishing mortality target, respectively.

Motion made by Dr. Davis and seconded by Mr. Estes.

Motion to Substitute

Move to substitute to set a TAC of 194,400 metric tons for 2021 and 2022.

Motion made by Ms. Meserve and seconded by Ms. Ware.

Motion to Amend

Move to amend the substitute motion to set a TAC of 194,400 metric tons for 2021 and 187,400 metric tons for 2022.

Motion made by Dr. Davis and seconded by Mr. Estes. Motion fails (6 in favor, 12 opposed).

Motion to Substitute

Move to substitute to set a TAC of 194,400 metric tons for 2021 and 2022.

Motion made by Ms. Meserve and seconded by Ms. Ware. Motion carries (12 in favor, 6 opposed).

Main Motion as Substituted

Move to set a TAC of 194,400 metric tons for 2021 and 2022.

Motion carries (13 in favor, 5 opposed). Roll Call: In Favor – ME, NH, MA, NY, NJ, PA, DE, MD, VA, PRFC, SC, NOAA Fisheries, USFWS; Opposed – RI, CT, NC, GA, FL.

SOUTH ATLANTIC STATE/FEDERAL FISHERIES MANAGEMENT BOARD (OCTOBER 20, 2020)

Press Release

ASMFC South Atlantic Board Approves Atlantic Cobia Addendum I

The Commission's South Atlantic States/Federal Fisheries Management Board approved Addendum I to Amendment 1 to the Interstate Fishery Management Plan for Atlantic Migratory Group Cobia. The Addendum modifies: (1) the allocation of the resource between the commercial and recreational sectors, (2) the methodology to calculate the commercial trigger for in-season closures; and (3) and commercial and recreational *de minimis* measures.

The Addendum changes the allocation of the resource between the recreational and commercial fisheries from 92% and 8% respectively to and 96% and 4% respectively. The change was primarily based on new recreational catch estimates that resulted from changes in survey methodology by

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the Marine Recreational Information Program. The new catch estimates were, on average, about two times higher than previously estimated, impacting the allocation between the two sectors. In considering the new allocation percentages, the Board took into account the increase in the recreational catch and the harvest levels of the commercial fishery in recent years. The new commercial allocation allows the fishery to operate at its current level with some room for landings to increase as the stock range expands further north.

The Addendum also modifies the calculation of the commercial trigger, which determines when an in-season coastwide commercial closure occurs. The approved trigger is set up to provide states with enough time to close the fishery via their administrative processes without exceeding the quota.

Changes to *de minimis* measures, which are applied to states with relatively small commercial or recreational harvest, include adjusting the commercial allocation set aside and recreational regulations. For *de minimis* measures, the Addendum establishes a commercial *de minimis* set aside of 4% of the commercial quota with a maximum cap of 5,000 pounds to account for potential landings in *de minimis* states not tracked in-season against the quota. States that are *de minimis* for their recreational fisheries may choose to match the recreational management measures implemented by an adjacent non-*de minimis* state (or the nearest non-*de minimis* state if none are adjacent), or limit its recreational fishery to 1 fish per vessel per trip with a minimum size of 33 inches fork length (or an equivalent total length of 37 inches).

States are required to implement the new measures by January 1, 2021. For more information, please contact Savannah Lewis, Fishery Management Plan Coordinator, at slewis@asmfc.org or 703.842.0740.

Meeting Summary
The South Atlantic State/Federal Fisheries Management Board met to consider approval of Atlantic Cobia Draft Addendum I (see above press release); review the spot and Atlantic croaker traffic light analyses (TLA) and resulting management triggers; and review and approve annual FMP Reviews, state compliance reports, and *de minimis* requests for red drum, Atlantic croaker, and Atlantic cobia.

Spot and Atlantic Croaker Traffic Light Analyses
The Chairs of the Spot and Atlantic Croaker Technical Committees (TC) presented the results of the annual TLAs for spot and Atlantic croaker. The TLA assigns a color (red, yellow, or green) to categorize relative levels of indicators on the condition of the fish population (abundance metric) or fishery (harvest metric). For example, as harvest or abundance increased relative to is long term mean, the proportion green in a given year will increase. The Board annually evaluates amounts of red against threshold levels to potentially trigger management action. In 2019, the TLA triggered for both spot and Atlantic croaker at the 30% level, or a moderate level of concern. Staff presented the resulting management responses outlined in Addenda III for Spot and Atlantic croaker. For both species, non *de minimis* states are required to institute a 50 fish bag limit for their recreational fishery, and non *de minimis* states must reduce commercial harvest by 1% of the average state commercial harvest from the previous 10 years. States with more restrictive measures in place are encouraged to keep them. The Board discussed the implementation timeline for states to make the required management changes. State implementation plans are due to the TC by February 12, 2021, with the Board meeting to occur by webinar the week of March 15, 2021, to approve the plans.

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Annual Fishery Management Plan Reviews
Staff presented annual FMP Reviews for red drum, Atlantic croaker, and Atlantic cobia. The Board considered *de minimis* requests from states for the three species, and approved all annual FMP reviews, state compliance reports, and *de minimis* requests. *De minimis* requests were approved for the red drum fisheries in New Jersey and Delaware. For Atlantic croaker, *de minimis* requests were approved for the recreational and commercial fisheries of New Jersey, and the commercial fisheries for Delaware, South Carolina, Georgia, and Florida. For Atlantic cobia, *de minimis* requests were approved New Jersey, Delaware, PRFC, and Maryland, and the commercial fishery for Georgia.

For more information, please contact Savannah Lewis, Fishery Management Plan Coordinator, at slewis@asmfc.org or 703.842.0740.

Motions
Main Motion
For Issue 1 recreational and commercial allocation, move to approve option C, 96% recreational and 4% commercial allocation.
Motion made by Mr. Gary and seconded by Mr. Cimino.

Motion to Substitute
Move to substitute to approve option B, 97% recreational and 3% commercial allocation.
Motion by Mr. Haymans and seconded by Mr. Bell. Motion fails (3 in favor, 7 opposed, 2 abstentions).

Main Motion
For Issue 1 recreational and commercial allocation, move to approve option C, 96% recreational and 4% commercial allocation.
Motion made by Mr. Gary and seconded by Mr. Cimino. Motion carries (8 in favor, 2 opposed, 2 abstentions).

For Issue 2 commercial trigger, move to approve option B, the new commercial trigger recommended by the Technical Committee.
Motion made by Mr. Geer and seconded by Mr. Bell. Motion carries by consent.

For Issue 3 commercial *de minimis* set aside move to approve option F, to account for potential landings in *de minimis* states not tracked in-season against the quota, 4% of the commercial quota or 5,000 pounds cap, whichever is less, would be set aside and not accessible to non-*de minimis* states.
Motion made by Mr. Cimino and seconded by Mr. Bell. Motion carries (11 in favor, 1 abstention).

For Issue 4 recreational *de minimis* size limit, move to approve option C, a recreational de minimis state may choose to match the recreational management measures implemented by an adjacent non-*de minimis* state (or the nearest non-*de minimis* state if none are adjacent) or limit its recreational fishery to 1 fish per vessel per trip with a minimum size of 33 inches fork length (or the total length equivalent, 37 inches).
Motion made by Mr. Geer and seconded by Mr. Bell. Motion carries.

Move to approve Addendum I to Amendment 1 to the Atlantic Cobia FMP as amended today.
Motion made by Mr. Bell and second by Mr. Geer. Motion carries without opposition.

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Move to approve the 2020 FMP Reviews, state compliance reports, and *de minimis* requests for red drum, Atlantic croaker, and Atlantic cobia.
Motion made by Mr. Batsavage and seconded by Mr. Estes. Motion carries by consent.

EXECUTIVE COMMITTEE (OCTOBER 21, 2020)

Meeting Summary

The Executive Committee met to discuss a number of issues, including the FY20 Audit; Management & Science Committee (MSC) recommendations regarding improvements to Advisory Panel (AP) and public input process and Pennsylvania's participation on the Atlantic Menhaden Management Board. The following action items resulted from the Committee's discussions:

- FY20 Audit – The Audit was reviewed by the Administrative Oversight Committee (AOC) and forwarded to the Executive Committee with a recommendation for approval. The motion to approve passed unanimously.
- Staff provided an update on future Annual Meetings, with plans to hold the 80th Annual Meeting in Long Branch, NJ in mid-October of 2021. Future Annual Meetings will be conducted in North Carolina (2022), Maryland (2023), and Delaware (2024).
- The Executive Committee received a progress report on the MSC recommendations regarding AP and the public input process. Staff has made progress on the public input portion of those recommendations, including posting presentations on documents currently out for public comment on the Commission's YouTube channel and webpage (e.g. Black Sea Bass Draft Addendum XXXIII) to increase the opportunities available to stakeholders to understand the issues and submit public comment. Staff will be working on an example survey of a draft management document to further facilitate public input and will consider possible improvements to the AP process early next year.
- Mr. Beal provided an update on the status of the Pennsylvania's membership on the Atlantic Menhaden Management Board. The Commission's guiding documents limit Pennsylvania's participation to diadromous species management activities. However, with the Atlantic Menhaden Board's recent adoption of ecological reference points formalizing the management linkages between striped bass and menhaden, there may be a sound argument for allowing Pennsylvania to remain on the Atlantic Menhaden Management Board. Staff will continue working with the Commission's Executive Committee to flesh out the details on Menhaden Board membership.

For more information, please contact Laura Leach, Director of Finance and Administration, at lleach@asmfc.org or 703.842.0740.

Motions

On behalf of the Administrative Oversight Committee, move acceptance of the FY20 Audit.
Motion made by Spud Woodward. Motion passed unanimously.

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HORSESHOE CRAB MANAGEMENT BOARD (OCTOBER 21, 2020)

Press Release

ASMFC Horseshoe Crab Board Sets 2021 Specifications for Horseshoe Crabs of Delaware Bay Origin

The Commission's Horseshoe Crab Management Board approved the harvest specifications for horseshoe crabs of Delaware Bay origin. Under the Adaptive Resource Management (ARM) Framework, the Board set a harvest limit of 500,000 Delaware Bay male horseshoe crabs and zero female horseshoe crabs for the 2021 season. Based on the allocation mechanism established in Addendum VII, the following quotas were set for the States of New Jersey, Delaware, and Maryland and the Commonwealth of Virginia, which harvest horseshoe crabs of Delaware Bay origin:

	2021 Delaware Bay Origin Horseshoe Crab Quota (no. of crabs)	2021 Total Quota**
State	**Male Only**	**Male Only**
Delaware	162,136	162,136
New Jersey	162,136	162,136
Maryland	141,112	255,980
Virginia*	34,615	81,331

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

** Total male harvest includes crabs which are not of Delaware Bay origin.

The Board chose a harvest package based on the Delaware Bay Ecosystem Technical Committee's and ARM Subcommittee's recommendation. The ARM Framework, established through Addendum VII, incorporates both shorebird and horseshoe crab abundance levels to set optimized harvest levels for horseshoe crabs of Delaware Bay origin. The horseshoe crab abundance estimate was based on data from the Benthic Trawl Survey conducted by Virginia Polytechnic Institute (Virginia Tech). This survey, which is the primary data source for assessing Delaware Bay horseshoe crab abundance, does not have a consistent funding source. Members of the Delaware and New Jersey U.S. Congressional Delegations, with the support of NOAA Fisheries, have provided annual funding for the survey since 2016.

For more information, please contact Caitlin Starks, Fishery Management Plan Coordinator, at 703.842.0740 or cstarks@asmfc.org.

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PR20-25

Meeting Summary

The Horseshoe Crab Management Board met to set specifications for the 2021 fishing season for horseshoe crab of Delaware Bay origin (see above press release); receive a progress update on revisions to the Adaptive Resource Management (ARM) Framework; consider approval of the Fishery Management Plan (FMP) Review and state compliance for 2019; and consider a nomination to the Horseshoe Crab Advisory Panel.

During the discussion on the 2021 specifications, the Board recognized a decline in the abundance estimate resulting from the 2019 Virginia Tech Trawl Survey. The Board requested further investigation into potential causes of the decline, and comparison to the composite abundance index that was developed from other available surveys when there was insufficient funding to run the Virginia Tech Trawl Survey.

Additionally, the Board considered a progress update on ongoing revisions to the ARM Framework. At the Board's direction, the ARM Subcommittee has been working on incorporating horseshoe crab population estimates from the Catch Multiple Survey Analysis (CMSA) model used in the 2019 Benchmark Stock Assessment into the ARM Framework, updating scientific information for horseshoe crab and red knots, moving the model to a new software platform, improving model structure, and updating the red knot population model. The ARM Subcommittee will meet for a second Assessment Workshop in early 2021, and is expected to present the complete ARM Framework to the Board in August or October 2021 after peer review.

The Board also reviewed the FMP Review and state compliance reports for the 2019 fishing year. All states' regulations were found to be consistent with the FMP and *de minimis* requests were granted to the Potomac River Fisheries Commission, South Carolina, Georgia, and Florida. The Board noted some concern related to increased biomedical mortality in 2019, and tasked the Technical Committee with evaluating the impact of recent biomedical mortality levels on the stocks.

Finally, the Board appointed a new member to the Horseshoe Crab Advisory Panel: Christina Lecker, a biomedical representative from Virginia. For more information, please contact Caitlin Starks, Fishery Management Plan Coordinator, at cstarks@asmfc.org or 703.842.0740.

Motions

Move to select harvest package 3 (500,000 male-only crabs) for 2021 horseshoe crab bait harvest in Delaware Bay.
Motion made by Mr. Nowalsky and seconded by Mr. Miller. Motion approved by consent.

Move to approve the FMP Review for the 2019 fishing year, state compliance reports, and *de minimis* status for Potomac River Fisheries Commission, South Carolina, Georgia, and Florida.
Motion made by Mr. Luisi and seconded by Dr. Rhodes. Motion approved by unanimous consent.

Move to appoint Christina Lecker to the Horseshoe Crab Advisory Panel.
Motion made by Mr. Geer and seconded by Mr. Bell. Motion approved by consent.

SPINY DOGFISH MANAGEMENT BOARD (OCTOBER 22, 2020)

Press Release

ASMFC Spiny Dogfish Board Sets Quotas for 2021-2023 Fishing Seasons

The Commission's Spiny Dogfish Management Board approved a commercial quota of 29.6 million pounds for the 2021/2022 and 2022/2023 fishing years (May 1–April 30). The quotas are consistent with the measures recommended to NOAA Fisheries by the Mid-Atlantic Fishery Management Council (Council). State-specific allocations are provided in table below.

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Spiny Dogfish State Allocations (in pounds) for the 2021-2023 Fishing Seasons

	Northern Region (ME-CT)	NY	NJ	DE	MD	VA	NC
Possession Limit	6,000	To be specified by the individual southern region states					
Allocation	**58%**	**2.707%**	**7.644%**	**0.896%**	**5.92%**	**10.795%**	**14.036%**
2021/22	17,144,556	800,413	2,259,728	264,866	1,749,935	3,191,020	4,149,062
2022/23	17,144,556	800,413	2,259,728	264,866	1,749,935	3,191,020	4,149,062

* Any overages in the above quotas will be deducted from that region's or state's quota allocation in the subsequent year. Similarly, any eligible rollovers from one season can be applied to that region's or state's quota allocation the following year.

Although the Board had previously set multi-year specifications for 2019-2021, in December 2019 the Council approved a new Risk Policy with the intent that 2021/2022 specifications would be revised to reflect the new policy. As such, the Council's Scientific and Statistical Committee (SSC) recommended increasing the acceptable biological catch (ABC) for 2021 from 35.4 million pounds to 38.6 million pounds. Based on this revised ABC recommendation, the Council approved a commercial quota of 29,559,580 pounds, which is an 8% increase compared to the previously set 2021/2022 quota. The Council also voted to extend these same specifications to the 2022 fishing year to align with the timing of the 2022 research track assessment. The Board works cooperatively with the Council in managing the spiny dogfish fishery in order to have consistency in state and federal waters. Neither the Board nor the Council recommended trip limit changes but the Council has plans in 2021 to conduct socioeconomic analyses of potential trip limit changes.

The Commission's actions are final and apply to state waters (0-3 miles from shore). The Mid-Atlantic and New England Fishery Management Councils will forward their recommendations for federal waters (3 –200 miles from shore) to NOAA Fisheries Greater Atlantic Regional Fisheries Administrator for final approval.

For more information, please contact Toni Kerns, ISFMP Director, at tkerns@asmfc.org or 703.842.0740.

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PR20-26

Motions

Move to revise the 2021/2022 fishing year spiny dogfish commercial quota to 29,559,580 pounds and to set the 2022/2023 fishing year quota at 29,559,580 pounds.

Motion made by Mr. Reid and seconded by Mr. Kane. Motion passes by unanimous consent.

Move to nominate Ms. Meserve as Vice-chair of the Spiny Dogfish Board.

Motion made by Ms. Ware and seconded by Ms. Patterson. Motion passes by unanimous consent.

ATLANTIC STRIPED BASS MANAGEMENT BOARD (OCTOBER 22, 2020)

Meeting Summary

The Atlantic Striped Bass Management Board met to consider approving state implementation plans for circle hook measures, which are required by Addendum VI; receive a Technical Committee (TC)

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report on release mortality in the recreational fishery; and review the first draft of the Public Information Document (PID) for Amendment 7.

The intent of the circle hook provision is to reduce release mortality when fishing with bait in recreational striped bass fisheries. All state proposals included final (or proposed) regulatory language and a definition for 'circle hook' comparable to that cited in Addendum VI. The Plan Review Team (PRT) noted a lot of variation in regulatory language among states, although all the regulations essentially say the same thing. The PRT reiterated concerns previously raised by the Law Enforcement Committee, stressing the importance of all jurisdictions agreeing on standardized regulatory language to improve compliance and enforcement, especially where states share common borders and fishing areas. Addendum VI also provides states flexibility to propose exemptions to mandatory circle hook requirements to address specific needs of the state fishery. Two states (Maine and Massachusetts) proposed exemptions, but the PRT was unable to make a definitive recommendation to the Board regarding exemptions due to limited guidance on what constitutes an acceptable level of flexibility. The Board discussed whether the proposed exemptions would lead to other 'niche' exemptions across state fisheries, further weakening enforceability and undermining the intent of the provision. In order to achieve the greatest level of conservation for the resource, the Board approved the state implementation plans, with the caveat that no exemptions to Addendum VI mandatory circle hook requirements will be permitted. Maine and Massachusetts will begin their rulemaking processes to remove exemptions to circle hook measures from state regulation.

The Board reviewed a TC report on release mortality in the recreational fishery, which constitutes a significant proportion of total fishing mortality on the stock. The report highlighted how recreational release mortality is calculated for stock assessments, the factors (data and modeling) limiting the accuracy of those estimates now and in the future, as well as potential management actions the Board could pursue to reduce release mortality in the fishery. Following review, the Board tasked the TC to explore the relative impact of different release mortality rate estimates on stock status, with the TC reporting back to the Board in February. The Board also reiterated the importance of hearing from the public on this issue as part of the adaptive management process within Amendment 7.

Lastly, the Board reviewed the first draft of the PID for Amendment 7. The PID is the first step in the amendment process; it is a broad scoping document intended to solicit stakeholder feedback on any issues concerning the management of the striped bass resource and fishery, and to inform development of the Draft Amendment. The PID highlights nine issues that have already been identified by the Board for consideration in Draft Amendment 7, including fishery goals and objectives, biological reference points, management triggers, stock rebuilding, regional management, conservation equivalency, recreational release mortality, recreational accountability, and the coastal commercial quota allocation. The Board offered a number of changes to the PID, including additions to the 'statement of the problem' and questions to the public to help focus stakeholder feedback. The Board will consider approving the PID for public comment in February 2021 at the Winter Meeting after these changes and additions have been addressed.

Finally, the Board appointed Bob Danielson, a recreational angler from New York, to the Striped Bass Advisory Panel. For more information, please contact Max Appelman mappelman@asmfc.org, Fishery Management Plan Coordinator, or Toni Kerns tkerns@asmfc.org, ISFMP Director, or at 703.842.0740.

Motions

Main Motion

Motion to not exempt any state from putting in place the circle hook rules for bait fishing as specified in Addendum VI.

Motion made by Mr. Fote and seconded by Mr. Abbott.

Motion to Substitute

Motion to substitute to approve the Addendum VI state implementation plans for circle hooks with the exception of the Massachusetts for hire exemption

Motion made by Ms. Ware and seconded by Dr. Davis. Motion fails (5 in favor, 8 opposed, 2 abstentions, 1 null).

Main Motion

Motion to not exempt any state from putting in place the circle hook rules for bait fishing as specified in Addendum VI.

Motion made by Mr. Fote and seconded by Mr. Abbott. Motion passes (15 in favor, 1 opposed). Roll Call: In Favor – MA, NY, MA, RI, NY, NJ, PA, DE, MD, VA, NC, DC, PRFC, NMFS, USFWS; Opposed – CT.

Move to nominate to the Atlantic Striped Bass Advisory Panel Bob Danielson from New York.

Motion made by Ms. Davidson and seconded by Mr. Fote. Motion adopted by consent.

ATLANTIC COASTAL COOPERATIVE STATISTICS PROGRAM COORDINATING COUNCIL (OCTOBER 23, 2020)

Meeting Summary

The ACCSP Coordinating Council met to elect a new chair and vice-chair and take action on ranked proposals to allocate funding for FY2021. The Council elected John Carmichael (SAFMC) as Chair, and Jason McNamee (RI) as Vice-chair. The Council and staff extended appreciation to Lynn Fegley (MD) for three years of leadership as Chair.

The Council opted to fund the FY2020 proposals as presented by the Advisory and Operations Committees. The Council discussed the increase in the ACCSP administrative grant and tradeoffs for funding across the areas of Partner projects vs. administrative costs, staff vs. contractor approach, and short-term vs. long-term benefits of program and project priorities. The Leadership Team will meet in the coming month to evaluate the administrative grant and carryover funds, and approaches to support coastal initiatives such as the SAFIS Helpdesk. The ACCSP Leadership Team will finalize the administrative grant budget and recommend alternatives for using any carry-over or additional funds to the Coordinating Council for consideration in February.

The Council will address the Operations Committee recommendations on future funding of maintenance projects under the step-down plan at the February Meeting.

The Council received brief highlights on committee and program updates, including completion of the Biological Resilience Project, partner coordination, and meaningful accomplishments in cybersecurity, data collection tools, Data Warehouse, and outreach. For more information, please contact Geoff White, ACCSP Director, at geoff.white@accsp.org.

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Motions

Move to elect Mr. Carmichael as Coordinating Council Chair.
Motion made by Ms. Fegley and seconded by Ms. Lupton. Motion carries by unanimous consent.

Move to elect Mr. Jason McNamee as Vice-chair.
Motion made by Ms. Patterson and second by Ms. Ware. Motion carries by unanimous consent.

Move to fund the submitted ACCSP proposals as ranked in Average Ranking table of proposals with the exception of the Administrative Grant proposal. That the Leadership Team evaluate a detailed ACCSP Administrative Grant before approving the Administrative Grant. That the funds from savings be brought to the Leadership Team for ranking of priority then back to the Coordinating Council.
Motion made by Ms. Patterson and seconded by Mr. Bell. Motion approved (18 in favor).

Move to adjourn.
Motion made by Mr. Bell and seconded by Ms. Patterson. Motion carries by unanimous consent.

BUISNESS SESSION (OCTOBER 23, 2020)

Meeting Summary

The Business Session reviewed and approved the 2021 Action Plan, which outlines the Commission's administrative and programmatic activities for next year. The Plan, which is guided by the Commission's 2019-2023 Strategic Plan, will be available on the Commission's website, www.asmfc.org, under Guiding Documents early next week. By unanimous acclamation, the Business Session re-elected Patrick C. Keliher of Maine and A.G. "Spud" Woodward of Georgia the Commission Chair and Vice-chair, respectively. For more information, please contact Robert Beal, Executive Director, at rbeal@asmfc.org or 703.842.0740.

Motions

Motion to approve the 2021 Action Plan.
Motion by made by Mr. Anderson and seconded by Mr. Fote. Motion passes.

On behalf of the Nominations Committee, move to nominate Mr. Keliher as Chair of ASMFC effective until the end of the next Annual Meeting.
Motion made by Mr. Gilmore. Motion passes.

On behalf of the Nominations Committee, move to nominate Mr. Woodward as vice-chair of ASMFC effective at the end of the meeting.
Motion made by Mr. Gilmore. Motion passes.

INTERSTATE FISHERIES MANAGEMENT PROGRAM (ISFMP) POLICY BOARD (OCTOBER 23, 2020)

Meeting Summary

The ISFMP Policy Board met to receive the Report from the Chair and an update from Executive Committee; consider dividing the species managed by the South Atlantic State/Federal Management Board into two new boards; determine the process for setting the 2021 coastal sharks specifications;

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discuss a whelk workshop; consider letters from the American Lobster Board and the Atlantic Striped Bass Board; and receive an update on the Horseshoe Crab FMP Review.

Commission Chair Patrick C. Keliher from Maine opened up the Policy Board meeting with his Annual Report to the Commission. The Report will be included in the next issue of *Fisheries Focus* for those interested in reading the report in full. The Chair also presented the Executive Committee Report to the Board (see Executive Committee meeting summary earlier in this document).

Based on the growing number of species under the purview of the South Atlantic State/Federal Fisheries Management Board, the Policy Board agreed to divide its species among two newly created boards: a Coastal Pelagics Board, which will oversee the management of Atlantic cobia and Spanish mackerel, and a Sciaenids Board, which will oversee the management of spot, red drum, black drum, Atlantic croaker, and spotted sea trout. This division will allow each Board to provide the appropriate amount of time and attention to its respective species, without compromising its focus on other species due to time limitations. Additionally, given the expanding ranges of some species, the new Board configuration will allow more northern states to effectively engage on species management programs for which they have a declared interest. As part of the new board structure, the South Atlantic Fishery Management Council be invited to join both Boards to ensure continued collaboration between state and federal management.

The Policy Board agreed to set the 2021 coastal sharks specification via an email vote after NOAA Fisheries has published a final rule. NOAA Fisheries is proposing a January 1 start date for all shark management groups, as well as an initial 36 shark possession limit for large coastal and hammerhead management groups with the possibility of in season adjustments.

Dan McKiernan updated the Board about recent efforts to reinitiate a symposium to allow states to share information about whelk science and management. Virginia Sea Grant has offered to fund and facilitate a workshop for the states. While the pandemic significantly slowed planning for the workshop, progress is now being made to host a webinar with the states.

The Policy Board agreed to send two letters on behalf of the American Lobster Board. The first letter is to NOAA Fisheries and will request changes to how data is collected by NOAA for five of the lobster data elements, including (1) number of trap hauls in effort, (2) number of traps in water in effort, (3) traps per trawl in effort, (4) buoy lines in effort, and (5) number of buoy lines in the water (see the Lobster Board meeting summary for details). The second letter is to New York requesting the state implement all of the necessary regulations of the Jonah Crab FMP (see the Lobster Board meeting summary for details). The Chair of the Atlantic Striped Bass Board requested letters be sent to both Maine and Massachusetts detailing required changes with regards to each state's Addendum VI implementation plans given both states' circle hook exemptions were not approved by the Board. Both states agreed it was clear the actions they need to take and a letter was not necessary. The states will update the Atlantic Striped Bass Board at its next meeting of the changes made to their measures to meet the requirements of the FMP.

Lastly, the Board was informed a revised version of the Fishery Management Plan Review for the 2019 Fishing Year will be emailed to the Horseshoe Crab Board, Advisory Panel, and Technical Committees. One of the state compliance reports misreported biomedical collections for the 2019 fishing year. As a result, the total biomedical collections will decrease relative to what was presented to the Board earlier in the week. An updated version of the FMP Review will be posted to the Commission's website on the Horseshoe Crab webpage.

For more information, please contact Toni Kerns, ISFMP Director, at tkerns@asmfc.org or 703.842.0740.

Motions
Move to split the South Atlantic State/Federal Fisheries Management Board into a Pelagic Board and a Sciaenid Board.
Motion made by Mr. Cimino and seconded by Mr. Woodward. Motion passes by consensus.

Move to approve the 2021 coastal sharks specifications via an email vote after NOAA Fisheries publishes the final rule for the 2021 Atlantic Shark Commercial Fishing season.
Motion made by Mr. Batsavage and seconded by Mr. Estes. Motion passes by consensus.

Motion to adjourn.
Motion made by Mr. Fote and seconded by Mr. Bell. Motion passes.

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October 2020 Council Meeting Summary

The following summary highlights actions taken and issues considered at the Mid-Atlantic Fishery Management Council's meeting October 5-8, 2020. This meeting was conducted by webinar due to the ongoing COVID-19 pandemic. Presentations, briefing materials, motions, and webinar recordings are available at http://www.mafmc.org/briefing/october-2020.

During this meeting, the Council:

- Revised 2021 specifications for spiny dogfish and adopted new specifications for 2022
- Reviewed previously-implemented 2021 specifications for chub mackerel and recommended no changes
- Approved a list of eighteen recommendations in response to Executive Order 13921
- Received a report detailing updates made to the research priorities document and outlining plans for a comprehensive review of all priorities scheduled for 2021.
- Received updates on several ongoing EAFM activities
- Convened a joint meeting of the Council and SSC to support open communication and continue development of SSC activities in support of Council priorities
- Revised and finalized the range of alternatives for the Bluefish Allocation and Rebuilding Amendment*
- Reviewed progress on the Recreational Management Reform Initiative and agreed to initiate a joint framework/addendum and a joint amendment to address several recreational issues*
- Received a report from the Executive Committee regarding draft deliverables for the 2021 Implementation Plan

** Items denoted with an asterisk (*) were undertaken during joint meetings with the Atlantic States Marine Fisheries Commission's Bluefish Management Board or Policy Board.*

Spiny Dogfish 2021-2022 Specifications

The Council revised spiny dogfish specifications for the 2021 fishing year (begins May 1) and adopted new specifications for the 2022 fishing year. Although the Council had previously set multi-year specifications for 2019-2021, in December 2019 the Council approved a revised risk policy with the intent that 2021 specifications would be revised to reflect the new policy. As such, the Council's Scientific and Statistical Committee (SSC) recommended increasing the upcoming 2021 Acceptable Biological Catch (ABC) for 2021 from 35.4 million pounds to 38.6 million pounds. Based on this revised ABC, the Council approved a commercial quota of 29.6 million pounds, which is an 8% increase compared to the quota previously recommended for 2021 and a 27% increase compared to the current 2020 quota. The Council also voted to extend these same specifications for the 2022 fishing year, as recommended by staff and the SSC, to align with the timing of the 2022 research track assessment. The Council did not recommend any trip limit changes but plans to conduct socio-economic analyses of potential trip limit changes in 2021.

Chub Mackerel – 2021 Specifications Review

The Council reviewed the previously implemented 2021 catch and landings limits for Atlantic chub mackerel. After considering the recommendations of the SSC and Monitoring Committee, as well as the Advisory Panel Fishery Performance Report, they agreed that no changes are necessary to the previously implemented measures. Additional details about 2021 specifications are available here.

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Executive Order on Promoting American Seafood Competitiveness and Economic Growth

The Council approved a final list of recommendations in response to Executive Order (EO) 13921. Section 4 of the EO requires each of Regional Fishery Management Council to submit to the Secretary of Commerce a prioritized list of recommended actions to reduce burdens on domestic fishing and to increase production within sustainable fisheries, including a proposal for initiating action by May 6, 2021. The Council approved 18 recommendations covering a broad range of topics.

The Council approved eight "Council Actions," which are tasks that can be carried out primarily by the Council. These include a combination of new initiatives which will be added to the Council's 2021 Implementation Plan and ongoing initiatives that address the objectives of the EO:

- **Council Actions** – **New Initiatives**: (1) Consider increasing the *Illex* incidental possession limit for certain vessels after the Illex fishery closes. (2) Consider increasing the amount of butterfish that can be landed by vessels using smaller than 3-inch mesh. (3) Review and consider changes to the commercial minimum mesh size for summer flounder, scup, and black sea bass. (4) Analyze the potential socio-economic impacts of potential changes to the dogfish trip limit. (5) Initiate a framework to allow golden tilefish specifications to be set for more than 3 years.
- **Council Actions** – **Ongoing Initiatives**: (1) Continue development of the Recreational Reform Initiative and associated actions. (2) Continue to plan and participate in Climate Change Scenario Planning process. (3) Provide training and outreach to facilitate compliance with commercial eVTR requirements.

The Council also approved ten "Non-Council Actions" recommendations, which are directed to other agencies. Based on guidance provided by the Council, these recommendations will be organized and prioritized within three sub-categories:

- **Non-Council Actions** – **General**: (1) Modify the USFWS definition of *Shellfish* so that squid will be exempt from import/export rules and fees. (2) Provide increased funding and resources to address fishery reporting issues and improve fishery dependent data. (3) Evaluate the National Standard 1 guidelines relative to the Modern Fish Act and provide clarification on the Councils' flexibility to implement alternative recreational management approaches. (4) Establish federal policy requiring that imports of seafood should meet or exceed the U.S. standards of harvest.
- **Non-Council Actions** – **Offshore Wind**: (1) Provide additional funding to the Northeast Fisheries Science Center to support the design and evaluation of new supplemental surveys that can be integrated into stock assessments and existing time series. (2) Collect additional information on fishing and transit locations, especially for fisheries that are not fully covered by existing datasets.
- **Non-Council Actions** – **Highly Migratory Species (HMS)**: (1) Address the disparity between U.S. and foreign HMS harvesting standards (recommendations will address specific concerns related to gear requirements as well as a desire to restrict HMS imports from countries that do not meet U.S. harvesting standards). (2) Integrate Vessel Trip Reporting (VTR) and HMS reporting systems. (3) Require holders of HMS permits with a commercial sale endorsement to report catch and harvest of all species, as well as discarded/undersize fish. (4) Integrate the HMS and GARFO permitting database and USCG safety inspection database.

Additional background information on these topics is available in the briefing materials. Staff is preparing the Council's recommendations for final submission to NMFS. These will be made available on the Council's website in the coming weeks.

Research Priorities Update

The Council received a report detailing updates made to the research priorities document and outlining plans for a comprehensive review of all priorities scheduled for 2021. Last year, the Council approved the Five-Year (2020-2024) Research Priorities document which was re-organized and prioritized to develop a more useful, tactical, and

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strategic document to effectively advance scientific and management information by the Council. The 2020 update and 2021 review are intended to track, monitor, and improve the Council's research priorities document to ensure its successful implementation.

Ecosystem Approach to Fisheries Management Updates (EAFM)

The Council received progress on several ongoing activities in support of advancing the Council's EAFM guidance document. First, staff reviewed progress on the development of a management strategy evaluation (MSE) that will evaluate the biological and economic performance and trade-offs of management alternatives to minimize discards in the recreational summer flounder fishery. The MSE will specify management objectives, performance metrics, and identify uncertainties through an extensive management and stakeholder engagement process. A kick-off webinar and mock MSE workshop was held in September with relevant advisory panels and additional focused stakeholder workshops will occur over the next 12-15 months.

Staff also provided an update on a collaborative research project between the Council and a research team from Rutgers University. The project will test new methods and models to predict short-term (over the next 1-10 years) climate-induced movements of diverse species that better align with management timescales. Summer flounder, spiny dogfish, *Illex* squid, and gray triggerfish have been selected as the focal species and, to date, the model has been fitted to spiny dogfish data. Model development will continue through 2020, with forecast testing scheduled for 2021. It is anticipated the project will be completed sometime in 2022.

Joint Council/SSC Meeting

Building off the success of the first joint meeting of the Council and its Scientific and Statistical Committee (SSC) in 2019, a second joint meeting was held to support open communication and continue development of SSC activities in support of Council priorities. The Council provided direction to the SSC Economic Work Group regarding their proposal to use the draft 2021 Implementation Plan to develop three case studies to highlight a process and the types of economic information that could be provided to the Council. The Economic Work Group will present the three case studies to the Council in December. Other topics discussed by the Council and SSC included the potential science implications of missing 2020 data due to the COVID-19 pandemic and considerations and approaches to address the application of the new risk policy for a species like ocean quahog.

Bluefish Allocation and Rebuilding Amendment

The Council met jointly with the Bluefish Management Board (Board) to finalize the range of alternatives for the Bluefish Allocation and Rebuilding Amendment. The Council and Board reviewed recommendations from the Fishery Management Action Team (FMAT) and approved a range of alternatives for inclusion in a draft public hearing document.

Consistent with FMAT recommendations, the Council and Board reduced the range of alternatives for further consideration in this amendment. The state commercial allocation alternatives were condensed to better represent recent state-by-state landings trends in the bluefish fishery. The Council and Board also voted to remove the alternatives related to regional commercial allocations from further consideration in this action. Council and Board members were concerned that this management approach would result in a loss of autonomy and flexibility necessary for state fishery managers to effectively manage to the needs of their state's commercial fisheries. The Council and Board also removed the two rebuilding plan alternatives that were projected to rebuild the stock to its biomass target within 10 years. The Magnuson Stevens Act mandate to rebuild an overfished stock in as short a time as possible while taking into consideration biological and socioeconomic impacts was an important factor in this decision. Council and Board members reasoned that the three remaining rebuilding plan alternatives span a reasonable time period of 4 to 7 years. Lastly, the Council and Board refined the range of alternatives pertaining to the sector transfer process, whereby landings are transferred between the recreational and commercial

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sectors, and the *de minimis* provision, which would relieve a state from adopting certain fishery regulatory measures when its harvest has minimal contribution to the coastwide harvest of bluefish.

The Council and Board expect to approve a public hearing document at the joint February meeting. Additional information, including an updated list of issues addressed in this action, can be found at:
https://www.mafmc.org/actions/bluefish-allocation-amendment.

Recreational Management Reform Initiative

The Council and the ASMFC's Policy Board (Board) reviewed progress on the Recreational Management Reform Initiative and discussed next steps. After reviewing nine topics that were either recommended by the Recreational Management Reform Initiative Steering Committee or by stakeholders through scoping for two separate ongoing amendments, the Council and Board agreed to initiate a joint framework/addendum and a joint amendment to address several recreational issues.

The **framework/addendum** will further develop and consider the following topics and management issues:

- better incorporating MRIP uncertainty into the management process;
- guidelines for maintaining status quo recreational management measures (i.e., bag, size, and season limits) from one year to the next;
- a process for setting multi-year recreational management measures;
- changes to the timing of the recommendation for federal waters recreational management measures; and
- a proposal put forward by six recreational organizations called a harvest control rule.

The **amendment** would consider options for managing for-hire recreational fisheries separately from other recreational fishing modes (referred to as sector separation) and would also consider options related to recreational catch accounting such as private angler reporting and enhanced vessel trip report requirements for for-hire vessels.

The Council and Board may consider an initial draft range of alternatives for the framework/addendum, as well as a draft scoping document for the amendment, in early 2021. Additional information about the Recreational Management Reform Initiative can be found at https://www.mafmc.org/actions/recreational-reform-initiative.

Executive Committee - 2021 Implementation Plan

The Executive Committee met to discuss the 2021 Implementation Plan. The Council develops Implementation Plans each year to ensure progress toward achieving the goals and objectives of its 5-year strategic plan. First, the Committee received a progress update on the 2020 Implementation Plan. The Executive Director noted that despite the disruptions caused by the ongoing COVID-19 pandemic, the Council is on track with most of the actions and deliverables identified for this year. Status updates for each item are provided on pages 3-6 of the briefing materials. The Committee then reviewed and provided feedback on a draft list of deliverables that had been developed by staff for 2021. Staff noted that several items on the list (#55-59) were flagged as "Possible Additions" because they were being considered for inclusion in the Council's response to Executive Order 13921. These items will be moved to the main sections of the list in the next iteration reviewed at the December meeting.

The Executive Committee had a lengthy discussion about whether to move item #66 ("Initiate an action to implement a possession limit for frigate and bullet mackerel in the Mid-Atlantic") from the "Possible Additions" section to the proposed deliverables for 2021. A motion to make this change ultimately failed based on a tied vote. This action remains on the draft list of "Possible Additions" for consideration by the Council in December. The Committee requested that additional information be provided during the December Council meeting on why the South Atlantic Fishery Management Council decided against implementing a possession limit for these species, the potential connection between these species and the Mid-Atlantic Council's Fishery Management Plans (e.g., as prey for Council managed species or bycatch in Council managed fisheries), and the type of management action that could be used to implement a possession limit for these species in the Mid-Atlantic.

Next Meeting

The next meeting of the full Council will be held via webinar on **December 14-17, 2020**. A complete list of upcoming meetings can be found at https://www.mafmc.org/council-events.

August 2020 Council Meeting Report

The following summary highlights actions taken and issues considered at the Mid-Atlantic Fishery Management Council's meeting August 10-13, 2020. This meeting was conducted by webinar due to the ongoing COVID-19 pandemic. Presentations, briefing materials, and webinar recordings are available at http://www.mafmc.org/briefing/august-2020.

During this meeting, the Council:

- Adopted Atlantic mackerel and butterfish specifications for 2021-2022 and longfin squid specifications for 2021-2023
- Revised 2021 specifications for summer flounder, scup, and black sea bass based on the Council's new risk policy and updated ABCs
- Reviewed previously-implemented 2021 specifications for bluefish and recommended no changes*
- Approved a range of alternatives for the for the Summer Flounder, Scup, and Black Sea Bass Commercial/Recreational Allocation Amendment*
- Adopted 2021-2026 specifications for Atlantic surfclams and ocean quahogs and received updates on the commingling/discard issue and surfclam genetic study
- Elected officers, swore in three new members and two reappointed members, and bid farewell to three departing members
- Reviewed public input on Executive Order 13921 and provided direction on possible areas of focus
- Supported the formation of an SSC Socio Economic Working Group
- Agreed to send a letter to NEFMC requesting that the development of an amendment to address leasing in the full-time limited access sea scallop fishery be prioritized for 2021
- Agreed to send a second letter to GARFO and NEFSC expressing concern about the redeployment of observers and requesting an extension of the observer waiver through the end of the year

** Items denoted with an asterisk (*) were undertaken during joint meetings with the Atlantic States Marine Fisheries Commission's Summer Flounder, Scup, and Black Sea Bass Management Board or Bluefish Management Board.*

Mackerel, Squid, Butterfish Specifications

The Council adopted specifications for Atlantic mackerel (including a river herring and shad cap), longfin squid, and butterfish. The Council's recommendations are summarized in the table below (2020 values are provided for comparison purposes).

	Domestic Annual Harvest (DAH) *metric tons*			
	2020	**2021**	**2022**	**2023**
Atlantic Mackerel	*17,312*	17,312	17,312	N/A
Longfin Squid	*22,932*	22,932	22,932	22,932
Butterfish	*23,752*	6,350	11,495	N/A

Atlantic Mackerel 2021-2022 Specifications and River Herring/Shad Cap

The Council reviewed fishery landings and federal trawl survey indices through 2019 and considered recommendations from the Scientific and Statistical Committee (SSC), Monitoring Committee, Advisory Panel, and staff. Atlantic mackerel is currently under a rebuilding program designed to rebuild the stock by June 2023. The available information indicates that the stock status has not changed substantially since it was last reviewed.

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Accordingly, the Council voted to maintain the Acceptable Biological Catch (ABC) at 29,184 mt (metric tons), as recommended by the SSC. After accounting for Canadian landings, recreational catch, management uncertainty, and discards, the domestic annual harvest (i.e. "quota" or "DAH") would also remain 17,312 mt. A management track assessment for mackerel is expected in 2021.

In addition, the Council reviewed recent performance of the river herring and shad (RH/S) cap and voted to maintain the 129 mt cap for 2021-2022 as well. The 129 mt cap will continue to provide a high incentive for the fleet to avoid RH/S. Staff is developing a series of discussion papers later in the year that will consider issues including potential RH/S cap alignment with New England, localized bycatch hotspots, and use of trawl data to adjust the cap.

Longfin Squid 2021-2023 Specifications

The recent management track stock assessment for longfin squid concluded that the stock is not overfished, and the status of overfishing remains unknown. The Council reviewed recent fishery performance and considered recommendations from the SSC, Monitoring Committee, Advisory Panel (AP), and staff. Based on the recommendation of the SSC, the Council voted to maintain the ABC at 23,400 for 2021-2023. After a 2% reduction to account for commercial discards, this results in a status quo commercial quota of 22,932 mt. Another management track assessment for longfin squid is expected in 2023.

Butterfish 2021-2022 Specifications

The recent management track stock assessment for butterfish concluded that the stock is not overfished and overfishing is not occurring. However, declining recruitment has led to declines in biomass, and as of 2019 biomass is estimated to have been only 69% of the target. The Council considered two ABC approaches – a "varying" approach, which would set the ABC lower in 2021 and higher in 2022, and an "averaged" approach, which would produce an average ABC for both years. The Council ultimately selected the variable approach, as recommended by the SSC, and adopted ABCs of 11,993 and 17,854 for 2021 and 2022, respectively. After accounting for management uncertainty and discards (including a 3,884 mt cap for the longfin squid fishery), the Council recommended DAHs of 6,350 mt for 2021 and 11,495 for 2022. Although the 2021 DAH represents a 73% reduction compared to 2020, the reduced quota may not be constraining given recent low butterfish landings. A research track assessment for butterfish is expected in 2022.

Summer Flounder, Scup, and Black Sea Bass 2021 Specifications

The Council met jointly with the Atlantic States Marine Fisheries Commission's (ASMFC) Summer Flounder, Scup, and Black Sea Bass Management Board (Board) to review previously implemented 2021 specifications for summer flounder, scup, and black sea bass. In December 2019 the Council approved a revised risk policy with the intent that 2021 specifications would be revised to reflect the new policy. As such, the Council's SSC recommended new 2021 ABC limits for summer flounder, scup, and black sea bass. Based on the revised ABCs and other considerations, the Council and Board voted to revise the 2021 specifications for these species.

The table below summarizes the 2021 commercial quotas and recreational harvest limits (RHL) for summer flounder, scup, black sea bass recommended by the Council and Board (2020 values are provided for comparison purposes).

	Commercial Quota *millions of pounds*		**Recreational Harvest Limit** *millions of pounds*	
	2020	**2021**	*2020*	**2021**
Summer Flounder	*11.53*	12.49	*7.69*	8.32
Scup	*22.23*	20.50	*6.51*	6.07
Black Sea Bass	*5.58*	6.09	*5.81*	6.34

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Summer Flounder

The Council and Board received a data update, including fishery landings and federal trawl survey indices through 2019, and reviewed recommendations from the SSC, Monitoring Committee, Advisory Panel, and staff. Based on the SSC's recommendation to update measures based on the new risk policy, the Council and Board approved a revised ABC of 27.11 million pounds, which results in a commercial quota of 12.49 million pounds and an RHL of 8.32 million pounds for both years after accounting for expected discards. These revisions represent an approximately 8% increase from those currently implemented for 2020-2021.

Scup

The Council and Board received a data update, including fishery landings and federal trawl survey indices through 2019, and reviewed recommendations from the SSC, Monitoring Committee, Advisory Panel, and staff. Based on the SSC and Monitoring Committee recommendations to update measures based on the new risk policy, the Council and Board approved a revised ABC of 34.81 million pounds for 2021. This revised ABC represents a 13% increase from the currently implemented 2021 ABC and results in a commercial quota of 20.50 million pounds and an RHL of 6.07 million pounds in 2021.

The Council and Board also reviewed an evaluation of scup discards by mesh size, calendar quarter, and statistical area in the commercial fishery. Discards decreased in 2019, but they remain well above average in recent years. The Council and Board agreed with the Monitoring Committee recommendation that no immediate management action was needed but that discards should continue to be monitored.

Black Sea Bass

The Council and Board reviewed recent trends in commercial and recreational catch and federal trawl survey indices, as well as recommendations from the SSC, the Monitoring Committee, the Advisory Panel, and staff. They had an in-depth discussion of discard projections and the increased risk of overfishing under the revised 2021 ABC due to the reduced buffer between the OFL and the ABC. Based on the SSC's recommended ABC and the Monitoring Committee's recommendation for revised discard projections, the Council and Board approved a revised 2021 ABC of 17.45 million pounds, a commercial quota of 6.09 million pounds, and an RHL of 6.34 million pounds. The revised ABC is 16% higher than the previously implemented 2020-2021 ABC. The commercial quota and RHL are 9% higher than those previously implemented for 2020-2021. These represent the highest landings limits ever implemented by the Council and Board for black sea bass.

The Council and Board also reviewed the black sea bass recreational opening during February 2018-2020 and considered if changes are needed for February 2021. Based on Monitoring Committee's advice, they agreed to revise the values for initial expected February recreational harvest by state. These values are used by the states that participate in this optional season opening to adjust their recreational management measures for the rest of the year as needed to account for expected February harvest. States also have the option of adjusting their measures after February to account for estimated February harvest based on monitoring, rather than the initial expected harvest . However, all states that participate in the February opening must first adopt measures to account for the initial expected February harvest estimate. The revised expected February harvest estimates approved by the Council and Board reflect recent changes in the MRIP methodology.

Bluefish 2021 Specifications

The Council met jointly with the ASMFC's Bluefish Management Board to review previously implemented 2021 specifications for bluefish. As indicated in the summer flounder, scup, and black sea bass specification section, the Council approved a revised risk policy in December 2019 with the intent that 2021 specifications would be revised to reflect the new policy. However, the fact that bluefish is under a rebuilding plan led the Council's SSC to recommend no change to the previously implemented specifications. Based on these recommendations and other considerations, the Council and Board voted for a status quo bluefish ABC of 16.28 million pounds for 2021.

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For landings limits, the Council and Board decided to use the 2019 estimate for recreational discards as opposed to the Monitoring Committee's recommendation of an average discard estimate from 2017-2019, which results in an RHL of 8.34 million pounds. Commercial discards were considered negligible, resulting in a commercial quota of 2.77 million pounds. For 2021, no transfer was recommended from the recreational to commercial sector as the recreational sector is anticipated to harvest the entire RHL.

The table below summarizes 2021 commercial quotas and RHL for bluefish recommended by the Council and Board (2020 values are provided for comparison purposes).

	Commercial Quota *millions of pounds*		**Recreational Harvest Limit** *millions of pounds*	
	2020	**2021**	*2020*	**2021**
Bluefish	*2.77*	2.77	*9.48*	8.34

Summer Flounder, Scup, and Black Sea Bass Commercial/Recreational Allocation Amendment

The Council and Board reviewed alternatives recommended by the Fishery Management Action Team (FMAT) for inclusion in a public hearing document for the Summer Flounder, Scup, and Black Sea Bass Commercial/Recreational Allocation Amendment. This amendment considers potential modifications to the allocations of total allowable catch or landings between the commercial and recreational sectors for these three species. Based on guidance provided by the Council and Board in June, the FMAT developed draft alternatives for 1) revised commercial/recreational allocations, 2) recreational for-hire sector separation, 3) provisions for quota transfers between the commercial and recreational fisheries, and 4) provisions to allow future modifications to these measures via framework action instead of an amendment.

The Council and Board approved the FMAT-recommended range of alternatives for commercial/recreational allocation options. The groups considered a motion to add options to increase the commercial allocations by 5%; however, they did not approve this motion as they could not identify a supportable justification for this increase, and it is not consistent with the goal of the amendment. They also considered but did not approve a motion to postpone development of this action indefinitely in response to concerns over data uncertainty and potential industry impacts.

The Council and Board voted to remove the alternatives related to recreational for-hire sector separation from further consideration in this action, consistent with the Council and Bluefish Board's decision to remove this issue from the Bluefish Allocation Amendment at their August 6 joint meeting. The intent of removing this issue from these actions is to allow exploration of sector separation through a broader process involving all four species, such as through the ongoing Recreational Reform Initiative. The Council and Board intend to discuss the Recreational Reform Initiative, including sector separation, at their next joint meeting.

For transfer provisions, the Council and Board approved most of the FMAT-recommended alternatives. They removed an alternative that would have allowed for annual quota transfers with limited pre-defined guidelines. They also approved the FMAT-recommended alternatives for framework provisions. The Council and Board are expected to review and approve a public hearing document in December. Additional information regarding the amendment process and timeline is available at: https://www.mafmc.org/actions/sfsbsb-allocation-amendment.

Surfclams and Ocean Quahog Specifications and Other Management Issues

The Council received the results of the most recent management track stock assessments for Atlantic surfclam and ocean quahog, both of which concluded that overfishing is not occurring in the most recent year and that the probability of either stock being overfished is low. The Council also reviewed the regulatory history, fishery performance, and advisory panel recommendations for both fisheries. Staff recommended that specifications

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be set for 6 years (2021-2026) to create administrative efficiencies as a result of the new stock assessment process. Based on the ABC recommendations of the Council's SSC, the Council adopted the specifications in the table below. The commercial quota has not changed since 2004 for surfclams and since 2005 for ocean quahogs.

	Annual Catch Target *metric tons*	Commercial Quota *metric tons*
	2021-2026	
Atlantic Surfclam	29,363	26,218
Ocean Quahog	25,924*	24,689*

** For combined Maine and non-Maine quahog fishery.*

For surfclams, the Council also recommended continued suspension of the minimum shell-length requirements for 2021 given that the coastwide 30% threshold requiring a minimum size be implemented was not triggered. However, staff noted that the overall percentage of undersized clams is getting closer to the 30% trigger; therefore, the fishing industry is encouraged to work to avoid landing large numbers of undersized clams.

The Council also received an update on the surfclam/quahog commingling issue. As surfclams have shifted toward deeper water in recent years, catches including both surfclams and ocean quahogs ("commingling") have become more common. Current regulations do not allow both species to be landed on the same trip or to be placed in the same tagged cages. The Council is forming an FMAT to explore options to address this issue. The FMAT will meet for the first time this fall to develop an action plan.

Finally, the Council received an update on a surfclam genetic study being conducted by researchers at Cornell University. This study aims to document the distributions and habitat preferences of the commercially-harvested Atlantic surfclam (*Spisula solidissima solidissima*), and its sister-taxon, the Southern Surfclam (*Spisula solidissima similis*) in the nearshore waters of the US Northwest Atlantic. As part of this research, high resolution genomic techniques will be developed to quantify amount of gene flow connectivity between each taxon and verify hybridization. The original sampling plan has been significantly impacted by the cancellation of federal and state surveys due to COVID-19. The research team is now planning to use a combination of federal samples collected in 2019, other existing samples from about 25 locations, and possibly a few other commercial samples to fill the sampling gaps.

Election of Officers and Swearing in of New and Reappointed Council Members

During the yearly election of officers, the Council re-elected Mike Luisi as Chairman and elected Paul Weston (Wes) Townsend as Vice Chairman. Mr. Luisi has served as Maryland's designated state official since 2010 and has served as Council Chair since 2016. Mr. Townsend is currently in his second term as an appointed member holding Delaware's obligatory seat. He is the owner/operator of the F/V PAKA out of Indian River Inlet in DE and has extensive experience with commercial fishing in state and federal waters.

The Council swore in three new members: Paul Risi from North Babylon, NY, Michelle Duval from West Chester, PA, and Dan Farnham from Montauk, NY. Also sworn in were two reappointed members: Dewey Hemilright from Wanchese, NC, who is beginning his third full term on the Council, and Sonny Gwin from Berlin, MD, who is beginning his second term on the Council.

Departing Council Members

The Council bid farewell to three departing members: G. Warren Elliott, Laurie Nolan, and Steve Heins. Mr. Elliott was appointed to the Council in 2011 and served for three consecutive terms. From 2016 until his departure in 2020, Mr. Elliott served as the Council's Vice Chair. Ms. Nolan's long history with the Mid-Atlantic Council includes 7 years of involvement as a tilefish advisor prior to her first appointment to the Council in 2000. She served the maximum of three three-year terms from 2000 to 2009. In 2011 she was reappointed and served for another three terms. Mr. Heins first joined the Council in 2006 as the designated state official from New York and served for 11 years in this role. Following his retirement from the New York Department of Environmental Conservation in May 2017, Mr. Heins was appointed to New York's obligatory seat and served for one term.

Executive Order 13921

Staff provided a summary of public comments received on Executive Order 13921 on Promoting American Seafood Competitiveness and Economic Growth. The Executive Order tasks the regional fishery management councils with each developing a prioritized list of recommended actions to reduce burdens on domestic fishing and to increase production within sustainable fisheries. After reviewing public comments, the Council provided some additional feedback on possible topics that could be addressed on the list of recommendations. The Executive Committee is expected to meet by webinar to review a draft list for consideration by the full Council at the October meeting.

Other Business

SSC Report

Dr. Paul Rago, SSC Chair, presented a summary of the July 22-23 SSC Meeting. In addition to the ABC recommendations described in previous sections, the SSC also considered the role of economists and social scientists in the work of the SSC. Dr. Rago noted that there are a number of areas where economic and social sciences could contribute, such as increasing focus on ecosystem considerations, tradeoffs among user groups, and upcoming challenges of offshore energy development. In view of the recent increase in the number of social scientists on the SSC, a working group was proposed to better define the role of economists in the process of setting ABCs. The Council expressed support for this recommendation and also asked the working group to consider other opportunities to increase the socioeconomic input from the SSC in Council activities. The working group will scope out these topics which will be discussed further during the joint Council-SSC meeting in October.

Scallop Limited Access Leasing Program Request

The Council agreed to send a letter to the New England Fishery Management Council (NEFMC) requesting that the development of an amendment to address leasing in the full-time limited access sea scallop fishery be prioritized for 2021. This issue was raised in a letter from the Scallopers Campaign which noted that the sea scallop fishery is among the Mid-Atlantic's highest revenue fisheries and that 70% of limited access vessels support initiating the process to develop a leasing program.

Observer Program Letter

The Council discussed concerns about the planned redeployment of observers and at-sea monitors on August 14 for vessels with Greater Atlantic Region fishing permits. The Council previously addressed this issue in June and submitted a letter to the Greater Atlantic Regional Fisheries Office (GARFO) and Northeast Fisheries Science Center (NEFSC) about its concerns. The observer waiver was subsequently extended until August 14. During the Council's discussion on August 13, members of the Council and public participants noted continued concerns about the high risk of transmission of COVID-19 on fishing vessels. Several members of the fishing industry also raised concerns about liability. The Council tasked staff with writing a second letter, which was sent on August 13 and is available at https://www.mafmc.org/correspondence. The Council also directed staff to work with GARFO and NEFSC to begin analysis of the science and management impacts of this waiver extension.

Next Meeting

The next meeting of the full Council will be held via webinar on **October 6-8, 2020**. A complete list of upcoming meetings can be found at https://www.mafmc.org/council-events.

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South Atlantic Fishery Management Council

News Release

FOR IMMEDIATE RELEASE
September 18, 2020

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Council Focuses on Dolphin and Wahoo Management Measures During Meeting Week

Bullet and Frigate Mackerel designations approved; fishermen weigh in about Dolphin concerns

Bullet Mackerel and Frigate Mackerel aren't likely to show up on a dinner plate, but they are the preferred meal for prized game fish such as Wahoo and Blue Marlin and to a lesser extent Dolphin and other apex species found along the Atlantic coast. Members of the South Atlantic Fishery Management Council took action during their meeting this week via webinar to acknowledge the importance of Bullet and Frigate Mackerel, sometimes referred to as tuna, as forage fish by adding the two species to the Dolphin Wahoo Fishery Management Plan as ecosystem component species. The Dolphin Wahoo Plan is administered by the South Atlantic Council and management extends along the entire Atlantic Coast. The designation, through Amendment 12 to the Dolphin Wahoo FMP, comes at the request of the Mid-Atlantic Council and has been largely supported by both scientists and fishermen. The Council received 117 written public comments, the majority in favor of the designation. "Bullet tunas can be protected for the benefit of our offshore marlin, tuna, and wahoo fisheries without harming any existing commercial or recreational fisheries by designating them as Ecosystem Component species," said Heather Maxwell, tournament director for the annual Pirate's Cove Billfish Tournament held out of Oregon Inlet, North Carolina. "The management of these species is paramount to the future success of our tournaments," said Maxwell, noting the economic importance of the tournaments to the area's economy.

Concerns about Bullet and Frigate Mackerel began to emerge following the targeting of Chub Mackerel, another important forage fish, by commercial fishermen in the Mid-Atlantic following a downturn in the squid fishery in 2013. Commercial landings increased substantially in a single year, prompting the Mid-Atlantic Council quickly develop a plan to manage Chub Mackerel and protect other forage fish in the region from uncontrolled harvest. Bullet and Frigate Mackerel were included in the initial plan but were removed when the plan was reviewed by NOAA Fisheries. There isn't currently a directed commercial fishery for Bullet or Frigate Mackerel and recreational fishermen occasionally target the two species as bait. If approved by the Secretary of Commerce, the addition of the of these species to the Dolphin Wahoo FMP would provide an avenue to address management issues should they arise.

The Council continued work on other measures affecting the Dolphin and Wahoo fishery, including modifications to current annual catch limits, accountability measures, allocations, and recreational bag and vessel limits in draft Amendment 10 the Dolphin Wahoo FMP. The Council is will continue work on the amendment in December and public hearings are currently scheduled to be held in early 2021.

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Council Focuses on Dolphin *(continued)*

Council members received written comments and heard from fishermen during public comment, primarily charter captains in the Florida Keys expressing concerns about the Dolphin fishery in South Florida, with fishermen catching fewer fish and the absence of larger "bull" Dolphin being captured. The fishermen expressed concerns about the commercial longline fishery for Dolphin and possible impacts. The annual catch limit for Dolphin is currently allocated 90% recreational and 10% commercial.

Council members received a presentation from Dr. Wessley Merton with the Dolphinfish Research Tagging Program showing the distribution of Dolphin based on the program's tagging studies, noting the majority of the commercial fishery occurs outside of U.S. waters in the Caribbean, South America, and international waters. The Council will consider an additional amendment to the Dolphin Wahoo FMP addressing the longline fishery in the future.

Other Business:
The Council also developed a list of recommendations in response to the President's Executive Order to Promote American Seafood after reviewing input from stakeholders and advisory panel members. The recommendations include modernization of the Individual Transferable Quota (ITQ) program for the Wreckfish fishery, modifications to the Oculina Bank Habitat Area of Particular Concern, commercial electronic logbooks and commercial permits for the snapper grouper fishery. Recommendations will be provided to NOAA Fisheries for further consideration.

In response to a recent stock assessment for Red Porgy, the Council began work on an amendment for management measures to address overfishing, rebuild the stock and revise allocations. The stock has not rebuilt despite management efforts, with a rebuilding plan currently in place. Under the Magnuson Stevens Conservation and Management Act, the Council has two years to implement new measures.

The Council held elections during its meeting, electing Mel Bell, former Vice Chair and representative for the South Carolina Department of Natural Resources Marine Resources Division as its new Chair. Steve Poland, Council representative for the North Carolina Division of Marine Fisheries was elected Vice Chair. Council members acknowledged Jessica McCawley for her service as Chair over the past two years, noting her effective leadership through the challenges brought on by the COVID-19 pandemic.

Additional information about this week's meeting, including a meeting Story Map, committee reports, and briefing book materials is available from the Council's website at: https://safmc.net/safmc-meetings/council-meetings/. The next meeting of the South Atlantic Fishery Management Council is currently scheduled for December 7-11, 2020 in Wrightsville Beach, North Carolina.

The South Atlantic Fishery Management Council, one of eight regional councils, conserves and manages fish stocks from three to 200 miles offshore of North Carolina, South Carolina, Georgia and east Florida.

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South Atlantic Fishery Management Council

SUMMARY MOTIONS

September 14-17, 2020

This is a summary of the motions approved by the Council. Motions addressing actions and alternatives for FMP amendments are followed by text showing the result of the approved motion. Complete details on motions and other committee recommendations are provided in the Committee Reports available on the SAFMC website.

Snapper Grouper Committee

MOTION 1: DIRECT STAFF TO DO THE FOLLOWING:

- Prepare draft Red Porgy amendment for review at the December 2020 meeting.
- Prepare analysis to show length of commercial season under potential new ACL using average catch rates from recent years to present to the Snapper Grouper Advisory Panel in November 2020 and request recommendations on possible modifications to management measures.
- Request presentation from SERO to inform potential actions in Wreckfish ITQ Modernization Amendment (Amendment 48) for the December 2020 meeting.
- Convene a meeting of the Wreckfish ITQ shareholders and Wreckfish wholesale dealers via webinar ahead of the December 2020 meeting.
- Prepare the Wreckfish ITQ Modernization Amendment (Amendment 48) to be considered for scoping at the December 2020 meeting.
- Approve the list of topics for the AP meeting.

APPROVED BY COUNCIL

SEDAR Committee

MOTION 1: DIRECT STAFF TO COMPLETE THE FOLLOWING TASK:

- Present revised Statements of Work for the 2023 assessments of the snowy grouper and tilefish (golden) at the March 2021 meeting after the SSC has reviewed the Snowy Grouper Assessment (SEDAR 36 Update).

APPROVED BY COUNCIL

Dolphin Wahoo Committee

MOTION 1: APPROVE AMENDMENT 12 TO THE FISHERY MANAGEMENT PLAN FOR THE DOLPHIN WAHOO FISHERY OF THE ATLANTIC FOR FORMAL SECRETARIAL REVIEW AND DEEM THE CODIFIED TEXT AS NECESSARY AND APPROPRIATE. GIVE STAFF EDITORIAL LICENSE TO MAKE ANY NECESSARY EDITORIAL CHANGES TO THE DOCUMENT/CODIFIED TEXT AND GIVE THE COUNCIL CHAIR AUTHORITY TO APPROVE THE REVISIONS AND RE-DEEM THE CODIFIED TEXT.

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APPROVED BY COUNCIL

MOTION 2: SELECT ALTERNATIVE 2 AS THE PREFERRED ALTERNATIVE IN ACTION 1.

Action 1. Revise the total annual catch limit for dolphin to reflect the updated acceptable biological catch level.

Preferred Alternative 2. The total annual catch limit for dolphin is equal to the updated acceptable biological catch level.

APPROVED BY COUNCIL

MOTION 3: SELECT ALTERNATIVE 2 AS PREFERRED UNDER ACTION 2.

Action 2. Revise the total annual catch limit for wahoo to reflect the updated acceptable biological catch level.

Preferred Alternative 2. The total annual catch limit for wahoo is equal to the updated acceptable biological catch level.

APPROVED BY COUNCIL

MOTION 4: MOVE ALTERNATIVES 2 AND 3 IN ACTION 3 TO THE CONSIDERED BUT REJECTED SECTION.

Action 3. Revise sector allocations and sector annual catch limits for dolphin.

APPROVED BY COUNCIL

MOTION 5: APPROVE IPT SUGGESTED EDITS TO ALTERNATIVES 4, 5, AND 6 IN ACTION 3.

Action 3. Revise sector allocations and sector annual catch limits for dolphin.

Alternative 4. Allocate 93.75% of the revised total annual catch limit for dolphin to the recreational sector. Allocate 6.25% of the revised total annual catch limit for dolphin to the commercial sector. This is based on approximately maintaining the current commercial annual catch limit and allocating the remaining revised total annual catch limit to the recreational sector.

Alternative 5. Allocate 93.00% of the revised total annual catch limit for dolphin to the recreational sector. Allocate 7.00% of the revised total annual catch limit for dolphin to the commercial sector.

Alternative 6. Allocate 92.00% of the revised total annual catch limit for dolphin to the recreational sector. Allocate 8.00% of the revised total annual catch limit for dolphin to the commercial sector.

APPROVED BY COUNCIL

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MOTION 6: APPROVE IPT SUGGESTED EDITS WITH THE EXCEPTION OF ALTERNATIVE 1 IN ACTION 4.

Action 4. Revise sector allocations and sector annual catch limits for wahoo.

Alternative 2. Allocate 97.45% of the revised total annual catch limit for wahoo to the recreational sector. Allocate 2.55% of the revised total annual catch limit for wahoo to the commercial sector. This is based on the following formula for each sector:

- Sector apportionment = (50% * average of long-term catch (pounds whole weight)) + (50% * average of recent catch (pounds whole weight)).
- Long-term catch = 1999 through 2008; Recent catch = 2006 through 2008.

Alternative 3. Allocate 96.35% of the revised total annual catch limit for wahoo to the recreational sector. Allocate 3.65% of the revised total annual catch limit for wahoo to the commercial sector. This is based on the total catch between 1994 and 2007.

Alternative 4. Allocate 97.56% of the revised total annual catch limit for wahoo to the recreational sector. Allocate 2.44% of the revised total annual catch limit for wahoo to the commercial sector. This is based on approximately maintaining the current commercial annual catch limit and allocating the remaining total annual catch limit to the recreational sector.

Alternative 5. Allocate 97.00% of the revised total annual catch limit for wahoo to the recreational sector. Allocate 3.00% of the revised total annual catch limit for wahoo to the commercial sector.

APPROVED BY COUNCIL

MOTION 7: AMEND ALTERNATIVE 4 TO REFLECT A SMALL INCREASE IN THE COMMERCIAL ACL. REMOVE ALTERNATIVE 2 IN ACTION 4 TO THE CONSIDERED BUT REJECTED SECTION.

Action 4. Revise sector allocations and sector annual catch limits for wahoo.

Alternative 4. Allocate 97.55% of the revised total annual catch limit for wahoo to the recreational sector. Allocate 2.45% of the revised total annual catch limit for wahoo to the commercial sector. This is based on approximately maintaining the current commercial annual catch limit and allocating the remaining total annual catch limit to the recreational sector.

APPROVED BY COUNCIL

MOTION 8: REMOVE ACTION 5 TO THE CONSIDERED BUT REJECTED SECTION.

APPROVED BY COUNCIL

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MOTION 9: ACCEPT THE IPT SUGGESTED EDITS TO ACTION 7.

Action 7. Revise the trigger for the post season recreational accountability measures for dolphin.

Alternative 2. Implement post season accountability measures in the following fishing year if the recreational annual catch limits are constant and the 3-year geometric mean of landings exceed the recreational sector annual catch limit. If in any year the recreational sector annual catch limit is changed, the moving multi-year geometric mean of landings will start over.

Alternative 3. Implement post season accountability measures in the following fishing year if the summed total of the most recent past three years of recreational landings exceeds the sum of the past three years recreational sector annual catch limits.

Alternative 4. Implement post season accountability measures in the following fishing year if recreational landings exceed the recreational sector annual catch limit in two of the previous three fishing years or exceeds the total (commercial and recreational combined) annual catch limit in any one year.

Alternative 5. Implement post season accountability measures in the following fishing year if the total (commercial and recreational combined) annual catch limit is exceeded.

Alternative 6. Implement post season accountability measures in the following fishing year if the recreational annual catch limit is exceeded.

APPROVED BY COUNCIL

MOTION 10: ACCEPT THE IPT SUGGESTED EDITS TO ACTION 8 WITH THE EXCEPTION OF ALTERNATIVE 2.

Action 8. Revise the post-season recreational accountability measures for dolphin.

Alternative 3. Reduce the length of the following recreational fishing season by the amount necessary to prevent the annual catch limit from being exceeded in the following year. However, the length of the recreational season will not be reduced if the Regional Administrator determines, using the best available science, that it is not necessary.

Alternative 4. Reduce the bag limit in the following recreational fishing season by the amount necessary to prevent the annual catch limit from being exceeded in the following year. However, the bag limit will not be reduced if the Regional Administrator determines, using the best available science, that it is not necessary.

Alternative 5. Reduce the vessel limit in the following recreational fishing season by the amount necessary to prevent the annual catch limit from being exceeded in the following year. However, the vessel limit will not be reduced if the Regional Administrator determines, using the best available science, that it is not necessary.

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MOTION 11: ACCEPT THE IPT EDITS TO ACTION 9.

Action 9. Revise the trigger for the post season recreational accountability measures for wahoo.

Alternative 2. Implement post season accountability measures in the following fishing year if the recreational annual catch limits are constant and the 3-year geometric mean of landings exceed the recreational sector annual catch limit. If in any year the recreational sector annual catch limit is changed, the moving multi-year geometric mean of landings will start over.

Alternative 3. Implement post season accountability measures in the following fishing year if the summed total of the most recent past three years of recreational landings exceeds the sum of the past three years recreational sector annual catch limits.

Alternative 4. Implement post season accountability measures in the following fishing year if recreational landings exceed the recreational sector annual catch limit in two of the previous three fishing years or exceeds the total (commercial and recreational combined) annual catch limit in any one year.

Alternative 5. Implement post season accountability measures in the following fishing year if the total (commercial and recreational combined) annual catch limit is exceeded.

Alternative 6. Implement post season accountability measures in the following fishing year if the recreational annual catch limit is exceeded.

APPROVED BY COUNCIL

MOTION 12: ACCEPT THE IPT SUGGESTED EDITS TO ACTION 10 WITH THE EXCEPTION OF ALTERNATIVE 2.

Action 10. Revise the post-season recreational accountability measures for wahoo.

Alternative 3. Reduce the length of the following recreational fishing season by the amount necessary to prevent the annual catch limit from being exceeded in the following year. However, the length of the recreational season will not be reduced if the Regional Administrator determines, using the best available science, that it is not necessary.

Alternative 4. Reduce the bag limit in the following recreational fishing season by the amount necessary to prevent the annual catch limit from being exceeded in the following year. However, the bag limit will not be reduced if the Regional Administrator determines, using the best available science, that it is not necessary.

Alternative 5. Implement a vessel limit in the following recreational fishing season that would prevent the annual catch limit from being exceeded in the following year. However, the vessel limit will not be implemented if the Regional Administrator determines, using the best available science, that it is not necessary.

APPROVED BY COUNCIL

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MOTION 13: APPROVE THE FOLLOWING TIMING AND TASKS:

- Continue work on Amendment 10 for review at the December 2020 meeting.
- Write a follow-up letter to the Mid-Atlantic Council upon submittal of Amendment 12.

APPROVED BY COUNCIL

Executive Committee

MOTION 1: MOVE TO REQUIRE COUNCIL MEMBERS TO TAKE HARASSMENT PREVENTION TRAINING THROUGH THE COUNCIL SUBSCRIPTION SERVICE. TRAINING WILL BE VALID FOR 2 YEARS.

APPROVED BY COUNCIL

MOTION 2: MOVE TO APPROVE THE REVISED OC AP MEMBERSHIP STRUCTURE AND MAKE APPOINTMENTS IN DECEMBER 2020.

APPROVED BY COUNCIL

Advisory Panel Selection Committee

MOTION 1: REAPPOINT RITA MERRITT AND JEFF SOSS TO THE HABITAT PROTECTION AND ECOSYSTEM-BASED MANAGEMENT AP.

APPROVED BY COUNCIL

MOTION 2: REAPPOINT DOUG KELLY, SHELLY KRUEGER AND KATIE LATANICH TO THE OUTREACH AND COMMUNICATIONS AP.

APPROVED BY COUNCIL

MOTION 3: READVERTISE THE COMMERCIAL SEAT ON THE LAW ENFORCEMENT AP AND REAPPOINT NICKEY MAXEY TO THE LE AP.

APPROVED BY COUNCIL

MOTION 4: REAPPOINT GARY ROBINSON AND TOM ROLLER (NGO) TO THE MACKEREL COBIA AP. APPOINT PAUL RUDERSHAUSEN TO THE MACKEREL COBIA AP. CONSIDER THE STRUCTURE OF THE MACKEREL COBIA AP AT THE DECEMBER 2020 COUNCIL MEETING.

APPROVED BY COUNCIL

MOTION 5: REAPPOINT JACK COX AND ROBERT FREEMAN AND APPOINT CHRIS KIMREY TO THE SNAPPER GROUPER AP.

APPROVED BY COUNCIL

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MOTION 6: APPOINT ANDREW MAHONEY, TONY CONSTANT AND HARRY MORALES TO THE SNAPPER GROUPER AP.

APPROVED BY COUNCIL

MOTION 7: REAPPOINT DAVE SNYDER TO THE SNAPPER GROUPER AP.

APPROVED BY COUNCIL

MOTION 8: REAPPOINT VINCENT BONURA, RICHARD GOMEZ, JIMMY HULL, AND DAVID MOSS TO THE SNAPPER GROUPER AP.

APPROVED BY COUNCIL

MOTION 9: APPOINT CHRIS MILITELLO AND ANDREW FISH TO THE SNAPPER GROUPER AP.

APPROVED BY COUNCIL

SEDAR Appointments

MOTION 1: APPROVE SEDAR 76 (BLACK SEA BASS) AND SEDAR 78 (SPANISH MACKEREL) TABLE OF PANELISTS, OBSERVERS AND DATA PROVIDERS AS PROVIDED BELOW.

APPROVED BY COUNCIL

MOTION 2: APPROVE SCHEDULES FOR SEDAR 76 (BLACK SEA BASS) AND SEDAR 78 (SPANISH MACKEREL).

APPROVED BY COUNCIL

SUMMARY REPORT
DOLPHIN WAHOO COMMITTEE
SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL
Webinar
September 16, 2020

The Committee approved amended minutes from the June 2020 meeting and the agenda.

Adding Bullet and Frigate Mackerel to the Dolphin Wahoo FMP as Ecosystem Component Species: Amendment 12
The amendment would add bullet mackerel and frigate mackerel to the Dolphin Wahoo Fishery Management Plan and designate them as ecosystem component species. The Committee reviewed a summary of the effects for the amendment and the Council's rationale. The Committee made the following motion:

MOTION #1: APPROVE AMENDMENT 12 TO THE FISHERY MANAGEMENT PLAN FOR THE DOLPHIN WAHOO FISHERY OF THE ATLANTIC FOR FORMAL SECRETARIAL REVIEW AND DEEM THE CODIFIED TEXT AS NECESSARY AND APPROPRIATE. GIVE STAFF EDITORIAL LICENSE TO MAKE ANY NECESSARY EDITORIAL CHANGES TO THE DOCUMENT/CODIFIED TEXT AND GIVE THE COUNCIL CHAIR AUTHORITY TO APPROVE THE REVISIONS AND RE-DEEM THE CODIFIED TEXT.
APPROVED BY COMMITTEE
APPROVED BY COUNCIL

Revise Dolphin and Wahoo Management Measures: Amendment 10
Amendment 10 includes actions that accommodate updated recreational data from the Marine Recreational Information Program by revising the annual catch limits and sector allocations for dolphin and wahoo. The amendment also contains actions that implement various other management changes in the fishery including revising accountability measures, accommodating possession of dolphin and wahoo on vessels with certain unauthorized gears onboard, removing the operator card requirement, reducing the recreational vessel limit for dolphin, and allowing filleting of dolphin at sea onboard for-hire vessels North of the Virginia/North Carolina border.

The Committee discussed the amendment and provided the following guidance as well as made the following motions:

MOTION #2: SELECT ALTERNATIVE 2 AS THE PREFERRED ALTERNATIVE IN ACTION 1.
Action 1. Revise the total annual catch limit for dolphin to reflect the updated acceptable biological catch level
PREFERRED Alternative 2. The total annual catch limit for dolphin is equal to the updated acceptable biological catch level.
APPROVED BY COMMITTEE
APPROVED BY COUNCIL

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MOTION#3: SELECT ALTERNATIVE 2 AS PREFERRED UNDER ACTION 2.
Action 2. Revise the total annual catch limit for wahoo to reflect the updated acceptable biological catch level.
PREFERRED Alternative 2. The total annual catch limit for wahoo is equal to the updated acceptable biological catch level.
APPROVED BY COMMITTEE
APPROVED BY COUNCIL

MOTION #4: MOVE ALTERNATIVES 2 AND 3 IN ACTION 3 TO THE CONSIDERED BUT REJECTED SECTION.
Action 3. Revise sector allocations and sector annual catch limits for dolphin
~~**Alternative 2.** Allocate 93.95% 94.01%of the revised total annual catch limit for dolphin to the recreational sector. Allocate 6.05% 5.99% of the revised total annual catch limit for dolphin to the commercial sector. This is based on the total catch between 2008 and 2012. as reported in 2019 and does incorporate recreational landings from Monroe County, Florida.~~
~~**Alternative 3.** Allocate 94.91% of the revised total annual catch limit for dolphin to the recreational sector. Allocate 5.09% of the revised total annual catch limit for dolphin to the commercial sector. This is based on the total catch between 1994 and 2007.~~
APPROVED BY COMMITTEE
APPROVED BY COUNCIL

MOTION #5: APPROVE IPT SUGGESTED EDITS TO ALTERNATIVES 4, 5, AND 6 IN ACTION 3.
Action 3. Revise sector allocations and sector annual catch limits for dolphin
Alternative 4. Allocate 93.75% of the revised total annual catch limit for dolphin to the recreational sector. Allocate 6.25% of the revised total annual catch limit for dolphin to the commercial sector. This is based on approximately maintaining the current commercial annual catch limit ~~of 1,534,485 pounds whole weight~~ and allocating the remaining revised total annual catch limit to the recreational sector.
Alternative 5. Allocate 93.00% of the revised total annual catch limit for dolphin to the recreational sector. Allocate 7.00% of the revised total annual catch limit for dolphin to the commercial sector.
Alternative 6. Allocate 92.00% of the revised total annual catch limit for dolphin to the recreational sector. Allocate 8.00% of the revised total annual catch limit for dolphin to the commercial sector.
APPROVED BY COMMITTEE
APPROVED BY COUNCIL

DIRECTION TO STAFF FOR ACTION 3:

- Revise and simplify Alternative 1 (No Action)

MOTION #6: APPROVE IPT SUGGESTED EDITS WITH THE EXCEPTION OF ALTERNATIVE 1 IN ACTION 4.
Action 4. Revise sector allocations and sector annual catch limits for wahoo
Alternative 2. Allocate 97.45% of the revised total annual catch limit for wahoo to the recreational sector. Allocate 2.55% of the revised total annual catch limit for wahoo to the

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commercial sector. This is based on the following formula for each sector: ~~using landings data as reported in 2019 and does incorporate recreational landings from Monroe County, Florida.~~
Sector apportionment = (50% * average of long-term catch (pounds whole weight)) + (50% * average of recent catch (pounds whole weight)).
Long-term catch = 1999 through 2008; Recent catch = 2006 through 2008
Alternative 3. Allocate 96.35% of the revised total annual catch limit for wahoo to the recreational sector. Allocate 3.65% of the revised total annual catch limit for wahoo to the commercial sector. This is based on the total catch between 1994 and 2007.
Alternative 4. Allocate 97.56% of the revised total annual catch limit for wahoo to the recreational sector. Allocate 2.44% of the revised total annual catch limit for wahoo to the commercial sector. This is based on approximately maintaining the current commercial annual catch limit ~~of 70,542 pounds whole weight~~ and allocating the remaining total annual catch limit to the recreational sector.
Alternative 5. Allocate 97.00% of the revised total annual catch limit for wahoo to the recreational sector. Allocate 3.00% of the revised total annual catch limit for wahoo to the commercial sector.
APPROVED BY COMMITTEE
APPROVED BY COUNCIL

DIRECTION TO STAFF FOR ACTION 4:
- Revise and simplify Alternative 1 (No Action).

MOTION #7: AMEND ALTERNATIVE 4 TO REFLECT A SMALL INCREASE IN THE COMMERCIAL ACL. REMOVE ALTERNATIVE 2 IN ACTION 4 TO THE CONSIDERED BUT SECTION.
Action 4. Revise sector allocations and sector annual catch limits for wahoo
~~**Alternative 2.** Allocate 97.45% of the revised total annual catch limit for wahoo to the recreational sector. Allocate 2.55% of the revised total annual catch limit for wahoo to the commercial sector. This is based on the following formula for each sector: using landings data as reported in 2019 and does incorporate recreational landings from Monroe County, Florida.~~
~~Sector apportionment = (50% * average of long-term catch (pounds whole weight)) + (50% * average of recent catch (pounds whole weight)).~~
~~Long-term catch = 1999 through 2008; Recent catch = 2006 through 2008~~
Alternative 4. Allocate ~~97.56%~~ 97.55% of the revised total annual catch limit for wahoo to the recreational sector. Allocate ~~2.44%~~ 2.45% of the revised total annual catch limit for wahoo to the commercial sector. This is based on approximately maintaining the current commercial annual catch limit ~~of 70,542 pounds whole weight~~ and allocating the remaining total annual catch limit to the recreational sector.
APPROVED BY COMMITTEE
APPROVED BY COUNCIL

MOTION #8: REMOVE ACTION 5 TO THE CONSIDERED BUT REJECTED SECTION.
~~*Action 5. Revise the commercial accountability measures for dolphin*~~
~~**Alternative 1 (No Action).** The current commercial accountability measure includes an in-season closure to take place if the commercial annual catch limit is met or projected to be met. If the commercial annual catch limit is exceeded, it will be reduced by the amount of the~~

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~~commercial overage in the following fishing year only if the species is overfished and the total annual catch limit is exceeded.~~
~~**Alternative 2.** If commercial landings for dolphin reach or are projected to reach the commercial annual catch limit, close the commercial sector for the remainder of the fishing year.~~
APPROVED BY COMMITTEE
APPROVED BY COUNCIL

OTHER DIRECTION TO STAFF:

- The subsequent action (Action 6) that focuses on the commercial accountability measures for wahoo is not approved by the Committee and will not be further considered in Amendment 10.

MOTION #9: ACCEPT THE IPT SUGGESTED EDITS TO ACTION 7.
Action 7. Revise the trigger for the post season recreational accountability measures for dolphin
Alternative 2. Implement post season accountability measures in the following fishing year if the recreational annual catch limits are constant and the 3-year geometric mean of landings exceed the recreational sector annual catch limit. If in any year the recreational sector annual catch limit is changed, the moving multi-year geometric mean of landings will start over.
Alternative 3. Implement post season accountability measures in the following fishing year if the summed total of the most recent past three years of recreational landings exceeds the sum of the past three years recreational sector annual catch limits.
Alternative 4. Implement post season accountability measures in the following fishing year if recreational landings exceed the recreational sector annual catch limit in two of the previous three fishing years or exceeds the total (commercial and recreational combined) annual catch limit in any one year.
Alternative 5. Implement post season accountability measures in the following fishing year if the total (commercial and recreational combined) annual catch limit is exceeded.
Alternative 6. Implement post season accountability measures in the following fishing year if the recreational annual catch limit is exceeded.
APPROVED BY COMMITTEE
APPROVED BY COUNCIL

MOTION #10: ACCEPT THE IPT SUGGESTED EDITS TO ACTION 8 WITH THE EXCEPTION OF ALTERNATIVE 2.
Action 8. Revise the post-season recreational accountability measures for dolphin
~~**Alternative 2**. Reduce the recreational sector annual catch limit by the amount of the overage in the following year. Also reduce the length of the following recreational fishing season by the amount necessary to prevent the revised annual catch limit from being exceeded in the following fishing year. However, the recreational annual catch limit and recreational fishing season will not be reduced if the Regional Administrator determines, using the best available science, that it is not necessary.~~
Alternative 3. Reduce the length of the following recreational fishing season by the amount necessary to prevent the annual catch limit from being exceeded in the following year. However, the length of the recreational season will not be reduced if the Regional Administrator determines, using the best available science, that it is not necessary.

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Alternative 4. Reduce the bag limit in the following recreational fishing season by the amount necessary to prevent the annual catch limit from being exceeded in the following year. However, the bag limit will not be reduced if the Regional Administrator determines, using the best available science, that it is not necessary.

Alternative 5. Reduce the vessel limit in the following recreational fishing season by the amount necessary to prevent the annual catch limit from being exceeded in the following year. However, the vessel limit will not be reduced if the Regional Administrator determines, using the best available science, that it is not necessary.

APPROVED BY COMMITTEE
APPROVED BY COUNCIL

DIRECTION TO STAFF FOR ACTION 8:

- Add an alternative that would monitor for persistence in increased landings. Under this alternative, if landings are projected to be met, reduce the bag limit or vessel limit first and if needed reduce the length of the recreational fishing season by the amount necessary to prevent the annual catch limit from being exceeded.

MOTION #11: ACCEPT THE IPT EDITS TO ACTION 9.

Action 9. Revise the trigger for the post season recreational accountability measures for wahoo

Alternative 2. Implement post season accountability measures in the following fishing year if the recreational annual catch limits are constant and the 3-year geometric mean of landings exceed the recreational sector annual catch limit. If in any year the recreational sector annual catch limit is changed, the moving multi-year geometric mean of landings will start over.

Alternative 3. Implement post season accountability measures in the following fishing year if the summed total of the most recent past three years of recreational landings exceeds the sum of the past three years recreational sector annual catch limits.

Alternative 4. Implement post season accountability measures in the following fishing year if recreational landings exceed the recreational sector annual catch limit in two of the previous three fishing years or exceeds the total (commercial and recreational combined) annual catch limit in any one year.

Alternative 5. Implement post season accountability measures in the following fishing year if the total (commercial and recreational combined) annual catch limit is exceeded.

Alternative 6. Implement post season accountability measures in the following fishing year if the recreational annual catch limit is exceeded.

APPROVED BY COMMITTEE
APPROVED BY COUNCIL

MOTION #12: ACCEPT THE IPT SUGGESTED EDITS TO ACTION 10 WITH THE EXCEPTION OF ALTERNATIVE 2.

Action 10. Revise the post-season recreational accountability measures for wahoo

~~**Alternative 2**. Reduce the recreational sector annual catch limit by the amount of the overage in the following year. Also reduce the length of the following recreational fishing season by the amount necessary to prevent the revised annual catch limit from being exceeded in the following fishing year. However, the recreational annual catch limit and recreational fishing season will not~~

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~~be reduced if the Regional Administrator determines, using the best available science, that it is not necessary.~~

Alternative 3. Reduce the length of the following recreational fishing season by the amount necessary to prevent the annual catch limit from being exceeded in the following year. However, the length of the recreational season will not be reduced if the Regional Administrator determines, using the best available science, that it is not necessary.

Alternative 4. Reduce the bag limit in the following recreational fishing season by the amount necessary to prevent the annual catch limit from being exceeded in the following year. However, the bag limit will not be reduced if the Regional Administrator determines, using the best available science, that it is not necessary.

Alternative 5. Implement a vessel limit in the following recreational fishing season that would prevent the annual catch limit from being exceeded in the following year. However, the vessel limit will not be implemented if the Regional Administrator determines, using the best available science, that it is not necessary.

APPROVED BY COMMITTEE
APPROVED BY COUNCIL

DIRECTION TO STAFF FOR ACTION 10:

- Add an alternative that would reduce the bag limit or implement a vessel limit while monitoring for persistence in increased landings. Under this alternative, if landings met or were projected to meet the sector ACL with the reduced bag limit or vessel limit in place, an in-season closure would occur.

OTHER DIRECTION TO STAFF:

- In Action 12, revise the action to also accommodate spiny lobster traps.

Dolphinfish Research Program Presentation

Dr. Wessley Merten, Director of the Dolphinfish Research Program, presented on recent research into dolphin movements, migration patterns, and fisheries in the Western Atlantic. This presentation was meant to inform the Committee on recent research that has been conducted on the topics and address a previous request from the Committee for such information. This agenda item was a summarized version of the more detailed presentation provided at the Dolphinfish Research Program Seminar that took place on August 26th via webinar.

Topics for the October 2020 Dolphin Wahoo Advisory Panel meeting and Other Business

Due to time constraints, the Committee was not able to address the draft list of topics for the upcoming Dolphin Wahoo Advisory Panel (AP) meeting or Other Business. The Committee reviewed and approved the list of topics for the AP meeting during the Full Council session.

Timing and Tasks:

MOTION #13: APPROVE THE FOLLOWING TIMING AND TASKS:

- CONTINUE WORK ON AMENDMENT 10 FOR REVIEW AT THE DECEMBER 2020 MEETING.
- WRITE A FOLLOW-UP LETTER TO THE MID-ATLANTIC COUNCIL UPON SUBMITTAL OF AMENDMENT 12.

APPROVED BY COUNCIL

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FINAL
SUMMARY REPORT
EXECUTIVE COMMITTEE
SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL
Meeting via Webinar
September 17, 2020

The Committee approved the meeting agenda and the minutes from the June 2020 meeting.

AP and SSC Composition

The Committee met in closed session to consider adding a seat to the SSC and revising the composition of the Outreach and Communication Advisory Panel. The Committee did not recommend increasing the number of seats on the SSC. The current seats and their designations are considered sufficient to meet Council needs. The Committee approved the proposed restructuring plan for the Outreach and Communication Advisory Panel. Appointments for revised seats will be considered in December and the structural changes will take place once appointments are made.

Harassment Prevention

The Committee met in closed session to consider modification to the SAFMC Handbook to address harassment prevention measures. The intent of the proposed changes is to clarify the Council policies on harassment prevention and workplace violence and provide guidance on how affected parties should respond. The Committee supported including the proposed language, with minor modifications for addressing meeting disruptions, in the handbook revisions. The handbook will be reviewed in its entirety and considered for approval at a future meeting.

The Committee raised the issue of security at Council meetings and activities, particularly the Council's security obligations as a convener of public gatherings. Because this issue has implications to the Council's MSA responsibilities and potentially impacts all Councils, guidance will be requested of NOAA GC and the question will be raised at the Council Coordination Committee.

Travel Forms

Kelly Klasnick reviewed revised Council travel authorization and reimbursement forms. The new forms may be submitted electronically and will become effective immediately. A training video will be developed and provided to Council travelers.

Council Priorities and Work Schedule

John Carmichael reviewed the Council priorities and amendment workplan for 2020, emphasizing changes resulting from the August 7, 2020 meeting. The Council was asked to consider two potential projects to add to the workplan: the ABC Control Rule amendment and Coral Amendment 10.

Council recommended proceeding to develop Coral Amendment to include one action considering establishing a shrimp fishery access area along the Eastern boundary of the Northern extension of the Oculina Bank CHAPC. The access area will be reviewed by the Habitat and Ecosystem and Shrimp APs and comments provided to the Council in December. Council will also review options and consider scoping approval in December.

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Council also recommended proceeding with SSC review on the ABC Control Rule Amendment at the SSC's October meeting, with a status report to the Council in December.

The Council supported the priorities for the December 2020 meeting and preliminary topics for the March 2021 meeting. Council members will be asked to individually prioritize FMP projects prior to the December meeting, and staff will develop solutions to the overload that develops in June 2021 for consideration in December 2020.

The Council will meet via webinar on November 9, 2020 from 10 am to 4 pm to discuss several recreational fisheries issues. Topics will include overview presentations on the recreational accountability measures and reporting amendments, a final report on the MyFishCount project, and a status report from the joint recreational working group.

MOTIONS

MOTION #1: MOVE TO REQUIRE COUNCIL MEMBERS TO TAKE HARASSMENT PREVENTION TRAINING THROUGH THE COUNCIL SUBSCRIPTION SERVICE. TRAINING WILL BE VALID FOR 2 YEARS.
APPROVED BY COMMITTEE
APPROVED BY COUNCIL

MOTION #2: MOVE TO APPROVE THE REVISED OC AP MEMBERSHIP STRUCTURE AND MAKE APPOINTMENTS IN DECEMBER 2020.
APPROVED BY COMMITTEE
APPROVED BY COUNCIL

ADDENDUM

Outreach and Communication Advisory Panel Seats

4 state agency seats: 1 ea from NC, SC, GA, FL
4 SeaGrant state program seats: 1 ea from NC, SC, GA, FL
4 fishermen seats: 1 ea from commercial, for-hire, private recreational, at-large
4 peer agency seats: 1 ea from GMFMC, MAFMC, CFMC, ASMFC
1 Coast Guard seat
1 SERO seat
1 media representative seat
2 at-large seats

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FINAL
SUMMARY REPORT
SEDAR COMMITTEE
SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL
September 15, 2020

The Committee approved minutes from the June 2020 meeting and agenda.

SEDAR ACTIVITIES UPDATE
The Committee was provided an overview of the research track and operational assessment process. The Committee wanted to ensure that public participation would still be part of the process.

STATEMENT OF WORK APPROVAL
The Committee was provided statements of work for 2023 assessments of Snowy Grouper and Tilefish. Currently assessments are ongoing for these two species and the Scientific and Statistical Committee requested time to revise the statements of work based on the findings of the assessment. The Committee requested the statements of work be brought back to Committee in March 2021 after review of the current Snowy Grouper assessment (SEDAR 36 Update). The Committee recognized the Tilefish assessment (SEDAR 66) would not be completed by then but statements of work need to be completed prior to the spring SEDAR Steering Committee.

STEERING COMMITTEE GUIDANCE
The Committee reviewed the current planning grid for SEDAR assessments and table of timing for completed and future assessments. The Committee recommended a Red Snapper Research Track Assessment as a high priority and Gray Triggerfish and Red Porgy as Operational Assessments.

The Committee did not make any motions.

Other Business:
No other business was brought before the committee.

Timing and Tasks:

DRAFT MOTION #1: DIRECT STAFF TO COMPLETE THE FOLLOWING TASK:
1. PRESENT REVISED STATEMENTS OF WORK FOR THE 2023 ASSESSMENTS OF SNOWY GROUPER AND TILEFISH (GOLDEN) AT THE MARCH 2021 MEETING AFTER THE SSC HAS REVIEWED THE SNOWY GROUPER ASSESSMENT (SEDAR 36 UPDATE).

APPROVED BY COUNCIL

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FINAL
SUMMARY REPORT
SNAPPER GROUPER COMMITTEE
SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL
SEPTEMBER 2020
(meeting held via webinar)

The Committee approved minutes from the June 2020 meeting and the agenda for the September 2020 Committee meeting.

Status of Amendments under Formal Review

NMFS SERO staff updated the Committee on the status of amendments under review or recently submitted:

- Regulatory Amendment 33 (Red Snapper Seasons): Final rule package has been sent to NMFS Headquarters.
- Abbreviated Framework 3 (Catch Levels for Blueline Tilefish): The final rule published on 7/16/20 and regulations became effective on 8/17/20.
- Regulatory Amendment 34 (SMZs in NC & SC): The amendment was submitted to NMFS on 8/11/20. NMFS is preparing the proposed rule package.

Review of Red Snapper 2020 Recreational Season

Council staff provided a summary of catch and effort data provided by the four South Atlantic states during the 2020 Red Snapper recreational season. Preliminary estimates from Florida suggest that 33,838 Red Snapper were harvested by private recreational anglers and 2,929 Red Snapper were harvested by charter boats. Council staff also updated the Committee on data obtained through the MyFishCount program. Note that the recreational ACL for red snapper in the South Atlantic is 29,656 fish.

Wreckfish ITQ Modernization (Amendment 48)

The Committee discussed the options paper for the modernization of the Wreckfish ITQ program. In September 2019, the Council approved the review of the Wreckfish ITQ program and directed staff to prepare an options paper for an amendment, including an action to modify the goals and objectives of the Snapper Grouper FMP by adopting those developed in the 2016-2020 Vision Blueprint for the Snapper Grouper Fishery. At this meeting, the Committee requested that staff convene a webinar meeting with Wreckfish ITQ shareholders and Wreckfish wholesale dealers prior to the December 2020 Council meeting to discuss the actions proposed in the options paper and make recommendations to the Council for potential additional actions. The Committee also requested that the group also discuss the possibility of requiring VMS on vessels participating in the Wreckfish fishery. The Committee decided to wait until the December 2020 meeting to consider Amendment 48 for public scoping in winter 2021. In addition, at the December 2020 meeting, the Committee requests that SERO staff deliver a presentation on how similar programs are administered in the Gulf of Mexico, including how cost recovery might be applied to the South Atlantic Wreckfish ITQ Program, issues surrounding the Wreckfish Permit and whether it is needed in the South Atlantic, and how electronic reporting could be implemented for the fishery.

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Red Porgy (Amendment 50)
At the June 2020 meeting, the Council directed staff to begin work on an amendment to end overfishing of Red Porgy, revise the rebuilding schedule, and address modifications to sector allocations and management measures. At this meeting, staff presented an overview of the options paper and requested guidance from the Committee on possible actions and a range of alternatives to develop for consideration at the December 2020 meeting. The Committee made no changes to the options presented but requested more information on whether a recreational ACT was needed. In addition, the Committee requested that the Snapper Grouper Advisory Panel (AP) provide recommendations on possible changes to management measures, including bag and trip limits, and seasonal/spawning closures. It was noted that commercial management measures for Red Porgy were recently modified with implementation of Vision Blueprint Regulatory Amendment 27. A draft timeline was presented that would complete development of the amendment by the statutory deadline of June 2022.

Topics for November 2020 Snapper Grouper Advisory Panel Meeting
The Snapper Grouper AP's scheduled April 2020 was cancelled due to the COVID-19 pandemic. The AP is scheduled to meet via webinar on November 4-6, 2020. Topics the Council approved for the AP's agenda are:

- Red Snapper fishery performance report
- Management measures for Red Porgy
- Recommendations on proposed ecosystem component species
- Use of descending devices
- Update on CitSci Projects
- Update on MyFishCount
- Input for Recreational Management Issues Webinar
- Update on Council Activities related to Climate Change

Other Business
There was no Committee discussion under Other Business.

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Timing and Tasks:

MOTION: DIRECT STAFF TO DO THE FOLLOWING:

- Prepare draft Red Porgy amendment for review at the December 2020 meeting.
- Prepare analysis to show length of commercial Red Porgy season under potential new ACL using average catch rates from recent years to present to the Snapper Grouper Advisory Panel in November 2020 and request recommendations on possible modifications to management measures.
- Request presentation from SERO to inform potential actions in Wreckfish ITQ Modernization Amendment (Amendment 48) for the December 2020 meeting.
- Convene a meeting of the Wreckfish ITQ shareholders and Wreckfish wholesale dealers via webinar ahead of the December 2020 meeting.
- Prepare the Wreckfish ITQ Modernization Amendment (Amendment 48) to be considered for scoping at the December 2020 meeting.
- Approve the list of topics for the AP meeting.

APPROVED BY COUNCIL

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ROY COOPER
Governor

MICHAEL S. REGAN
Secretary

STEPHEN W. MURPHEY
Director

October 22, 2020

MEMORANDUM

TO: N.C. Marine Fisheries Commission

FROM: Steve Poland, Executive Assistant for Councils & Highly Migratory Species lead

SUBJECT: Highly Migratory Species Update

Issue
Highly Migratory Species activity update.

Action Needed
For informational purposes only, **no action is needed at this time.**

Overview
The Highly Migratory Species (HMS) Advisory Panel (AP) met on September 9th and 10th, 2020 via webinar. The Advisory Panel discussed impacts from COVID-19 on HMS fisheries, reviewed Amendment 12 to the Consolidated Atlantic HMS FMP, discussed the 2020 bluefin tuna season and updated assessment, and received a presentation on shark depredation within commercial and recreational fisheries along the Atlantic.

Covid-19 impacts
Economist from NOAA Fisheries presented a presentation entitled "2020 Fisheries Economic Situation Report" summarizing the trends in revenue and effort within the commercial and recreational HMS fisheries due to COVID-19 pandemic restrictions. Of note, commercial landings values for HMS fisheries declined precipitously after March and ranged from 12-66% below monthly averages for the previous year. However, while ex-vessel prices declined after March, by July prices had rebounded to previous years' averages coinciding with the relaxation of many restaurant occupancy restrictions. The for-hire sector reported a significant drop in trips for the March through June survey periods. In contrast, private boat trips in the Southeast increased during this period when compared to 2019. However, fifty fewer HMS tournaments have been registered through August 2020 when compared to the previous year.

Amendment 12
Draft Amendment 12 to the Consolidated Atlantic HMS FMP proposes modifying the plan objectives and framework procedures to address changes to the National Standard guidelines and update triggers and timing of allocation decisions and stock assessment and fishery evaluation reports. Proposed actions in this amendment update the FMP with current NOAA Fisheries policies and guidelines and reporting requirements and updates and consolidates the FMP objectives. However, two actions being considered have the potential to modify how stock status of some fisheries are determined by adopting international determinations of stock status for some species and trigger more frequent deliberation on sector allocations. Comments on raft Amendment 12 are being accepted through October 26th with an anticipated final action in mid-2021.

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Bluefin Tuna

Staff from HMS provided a presentation summarizing landings trends in the Atlantic Bluefin Tuna fishery to date. Of interest to North Carolina fisherman, there was a notable increase in recreational landings coastwide and the commercial fishery had the highest landings of the general category quota during the January sub quota period (January – March) triggering a closure on February 28th. There was also a 33% increase in the number of 2020 Atlantic Tuna Permits compared to the previous 5-year average. NOAA Fisheries is considering resuming the use of Restricted Fishing Days (RFD) for the Atlantic Bluefin Tuna fishery in an effort to better constrain harvest for 2021. RFDs can be used to restrict fishing during certain days to improve the distribution of fishing opportunities throughout a quota subperiod. NOAA Fisheries expressed intent to gather public comment on the use of RFDs but has not yet published a formal scoping/public comment period.

Shark Depredation

Reports of shark depredations and frustrations from anglers have steadily increased over the last few years. Stakeholders and the Gulf and South Atlantic Fishery Management Councils have expressed concerns over the apparent increase in these events within their regions and requested that NOAA Fisheries consider these concerns in any upcoming management actions related to HMS sharks. Staff presented a preliminary analysis of shark depredations within HMS and other federally managed fisheries. Species most commonly depredated from longline trips were Swordfish and Yellowfin Tuna accounting for 57% of all interactions. Of these depredations, 83% were considered a total economic loss or only a head was retrieved. Incidence of shark depredation in the snapper-grouper fishery was much less but did show an increasing trend since the mid-2000s. More research and monitoring is need for recreational and for hire trips to quantify the extent and prevalence of shark depredations.

Closure of Recreational Atlantic Billfish

After the September AP meeting, NOAA Fisheries announced that the recreational landings limit for Atlantic Blue Marlin, White Marlin, and Roundscale Spearfish had been exceeded. NOAA Fisheries published a notice on September 10th prohibiting the retention on these species for the remainder of the fishing year. Catch information is still being finalized for the fishery and it is not yet clear on the management response for the 2021 season.

PROTECTED RESOURCES UPDATE

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ROY COOPER
Governor

MICHAEL S. REGAN
Secretary

STEPHEN W. MURPHEY
Director

October 23, 2020

MEMORANDUM

TO: Marine Fisheries Commission

FROM: Barbie Byrd, Biologist Supervisor
Protected Resources Program, Fisheries Management Section

SUBJECT: Protected Resources Program Update

Issues

Summary information is provided from the division's Protected Resources Program for the most recent Incidental Take Permit (ITP) seasonal report provided to National Marine Fisheries Service.

Overview

Summer 2020 Seasonal Report

The summer 2020 seasonal report for the Sea Turtle ITP is provided from the division's Protected Resources Program. A seasonal report is not required for the Atlantic Sturgeon ITP.

Due to protective measures to help prevent the spread of COVID-19, the Observer Program received a waiver from the National Marine Fisheries Service (NOAA Fisheries) for maintaining observer coverage until further notice. Nevertheless, Marine Patrol and observers have been conducting alternative platform observations.

There were no observed or reported incidental takes of sea turtles or Atlantic sturgeon during the 2020 summer season.

The summer 2020 seasonal report can be found at the following link:

Summer 2020 Seasonal Sea Turtle ITP Report

Action Needed

For informational purposes only, **no action is needed at this time**.

State of North Carolina | Division of Marine Fisheries
3441 Arendell Street | P.O. Box 769 | Morehead City, North Carolina 28557
252-726-7021

2020 Summer Seasonal Progress Report
Incidental Take Permit No. 16230
June 1 – August 31, 2020
(ITP Year 2020)

John McConnaughey
Protected Species Biologist
North Carolina Division of Marine Fisheries

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June 30, 2020

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SUMMARY

The summer season was June 1, 2020 through August 31, 2020 for Incidental Take Permit (ITP) Year 2020 (September 1, 2019 – August 31, 2020) as defined in ITP No. 16230. During this time, the North Carolina Division of Marine Fisheries (NCDMF) was still under a waiver from the National Marine Fisheries Service (NMFS) for maintaining observer coverage of anchored estuarine gill nets. The waiver had been provided on March 23, 2020 due to the COVID-19 pandemic. The observer program ceased conducting observations immediately; however, Marine Patrol officers, who are not required to have two staff per vessel, continued alternative platform observations.

In June 2020, the NCDMF outlined protocols for staff to resume limited field sampling while preventing the spread of COVID-19. For the Observer Program, these protocols included among other things, the use of alternative platform observations only and no overnight travel. The Observer Program resumed effort on June 6, 2020.

Between June 6 and August 31, 22 small mesh gill net trips were observed. No trips occurred on large mesh gill net trips because the fishery was closed in all management units during the 2020 summer season. Estimated observer coverage of small mesh gill nets during summer was 1.6% across all management units (Table 1). The minimum ITP requirement of 1% coverage was met or exceeded in all management units except for D1 where the estimated number of fishing trips was only seven.

Reports from Division staff indicated that fishing effort during summer was low due to COVID-19. As a result, the number of gill net trips observed by the OP and MP were low compared to the efforts made to find and observe fishing effort (see below). Data are not yet available for actual number of reported fishing trips. As a result, observer coverage estimates based on the previous five-year average do not account for reduced fishing effort due to the COVID-19 pandemic.

There were no observed or reported incidental takes of sea turtles during summer 2020.

Seasonal gill net openings and closings continued even though all indications were that fishing effort was low. A list of relevant proclamations is provided in Table 2.

During summer 2020, Marine Patrol made 423 attempts to find gill net effort and were successful 8 times for a success rate of 1.8% for alternative platform observations. Observer Program staff attempted to find alternative platform observations 60 times and succeeded in finding trips on 14 occasions for a success rate of 23%. These comparisons reinforce information that suggested fishing effort was low. During the course of Marine Patrol efforts to observe gill net fishing effort, no citations were issued.

As per the ITP, the division established a permit in September 2014 to register all fishermen participating in the anchored large and small mesh gill net fisheries (Estuarine Gill Net Permit – EGNP). This permit allows the division to monitor the number of fishermen who plan to

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participate in the fisheries and it outlines special conditions that the permit holder much comply with to operate in the fishery. As of August 31, 2020, there had been 1,956 EGNPs issued for Fiscal Year (FY) 2021 (July 1, 2020- June 30, 2021). Permits are renewed on an annual basis, based on the fiscal year for licenses. During the 2020 spring season there were zero Notice of Violations (NOV) written for violations of the EGNP.

During summer 2020, observers continued to call fishermen to set up alternative platform trips. Although observers logged 160 phone calls to fishermen, only one call was successful in scheduling an observable trip (Table 3). For the other 159 calls, the fisherman said they were not fishing anchored gill nets (n=45) or no contact was made (n=114).

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TABLES

Table 1. For small mesh gill nets, estimated percent observer coverage calculated from observer trips (< 4 inch) and estimated fishing trips from the Trip Ticket Program (< 5 inch) by management unit for summer 2020 (June - August). Estimated fishing trips were calculated as the 5-yr average of reported trips for 2015-2019 and do not account for potential reductions in fishing effort due to the COVID-19 pandemic.

Management Unit [1]	Trips		Coverage (%)
	Estimated (2015-2019) [2]	Observed	
A	164	3	1.8
B	836	10	1.2
C	117	3	2.6
D1	7	0	0.0
D2	45	2	4.4
E	203	4	2.0
Total	1,372	22	1.6

[1] Table 1 contains all of the openings and closings for each management unit

[2] Finalized trip ticket data averaged from 2015-2019

Table 2. Regulation changes affecting anchored large and small mesh gill net fisheries during summer (June - August) 2020.

Year	Date(s)	Regulation change
2020	June 15	This proclamation supersedes Proclamation FF-34-2019, dated September 12, 2019. It establishes commercial flounder season dates for Internal Coastal Waters by Flounder Management Area. It maintains a 15-inch total length minimum size limit. It also maintains the regulation making it unlawful to possess flounder taken from anchored large mesh gill nets with a stretched mesh length less than 6 inches. It makes it unlawful for a commercial fishing operation to possess flounder from the Atlantic Ocean Waters taken by any method other than trawls. This action is being taken to comply with the requirements of Amendment 2 to the N.C. Southern Flounder Fishery Management Plan. The flounder harvest period for the Northern Management Area will open at 12:01 A.M., Tuesday, September 15, 2020 and close at 8:00 P.M., Tuesday, October 6, 2020. The flounder harvest period for the Central Management Area will open at 12:01 A.M., Thursday, October 1, 2020 and close at 8:00 P.M., Monday, October 19, 2020. The flounder harvest period for the Southern Management Area will open at 12:01 A.M., Thursday, October 1, 2020 and close at 8:00 P.M., Monday, November 2, 2020. (FF-25-2020)
2020	July 22	This proclamation reduced the yardage limit for gill nets with a stretched mess length less than 4 inches in Management Unit B. Yardage limit decrease in Management Unit B were being implemented to coincide with the 500 lb daily trip limit in the commercial Spanish mackerel fishery. (M-12-2020)

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Table 3. Categories and descriptions of fishermen responses for the Observer Program's contact logs.

Categories	Category description
1	Left message with someone else
2	Not fishing general
3	Fishing other gear
4	Not fishing because of weather
5	Not fishing because of boat issues
6	Not fishing because of medical issues
7	Booked trip
8	Hung up, got angry, trip refusal
9	Call back later time/date
10	Saw in person
11	Disconnected
12	Wrong number
13	No answer
14	No answer, left voicemail
15	Not fishing because of natural disaster (e.g., hurricane)

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FIGURES

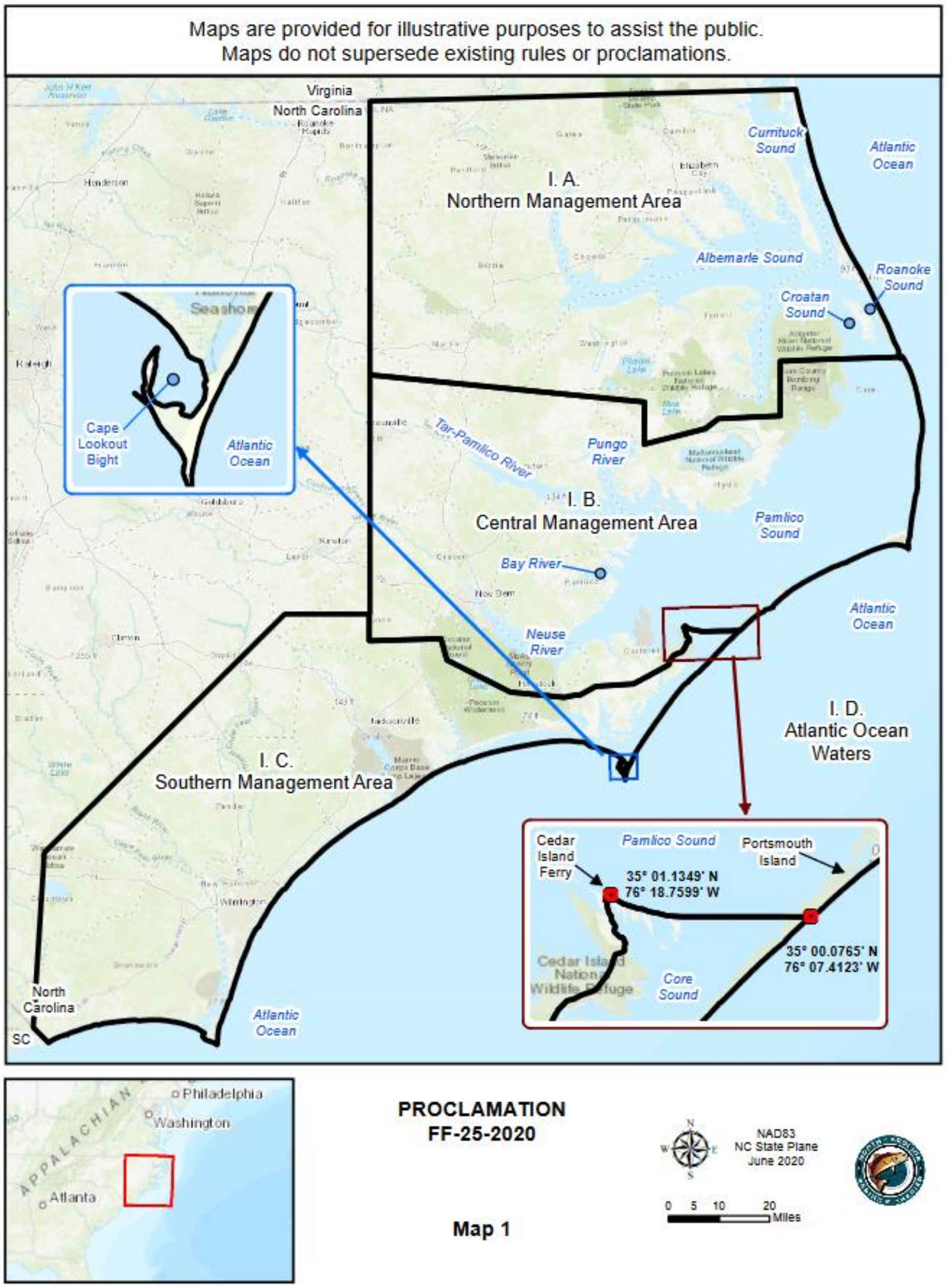

Figure 1. Map for proclamation F-25-2020. See Table 2 for full proclamation description.

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LANDINGS UPDATE FOR RED DRUM & SOUTHERN FLOUNDER

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Red Drum Landings 2019-2020

Landings are complete through October 28, 2020.
2019 landings are final. 2020 landings are preliminary.

Year	Month	Species	Pounds	2009-2011 Average	2013-2015 Average
2019	9	Red Drum	1,508	28,991	35,003
2019	10	Red Drum	8,080	43,644	63,659
2019	11	Red Drum	5,357	14,318	27,646
2019	12	Red Drum	1,763	3,428	2,197
2020	1	Red Drum	1,853	5,885	1,700
2020	2	Red Drum	1,322	3,448	3,996
2020	3	Red Drum	1,040	5,699	3,971
2020	4	Red Drum	2,425	7,848	6,528
2020	5	Red Drum	4,473	13,730	9,661
2020	6	Red Drum	5,890	12,681	6,985
2020	7	Red Drum	6,839	13,777	15,618
2020	8	Red Drum	13,592	21,252	15,846

FY20 Fishing Year (Sept 1, 2019 - Aug 31, 2020) Landings	**54,142**

Year	Month	Species	Pounds	2009-2011 Average	2013-2015 Average	
2020	9	Red Drum	28,308	28,991	35,003	*
2020	10	Red Drum	1,927	43,644	63,659	*
2020	11	Red Drum				
2020	12	Red Drum				
2021	1	Red Drum				
2021	2	Red Drum				
2021	3	Red Drum				
2021	4	Red Drum				
2021	5	Red Drum				
2021	6	Red Drum				
2021	7	Red Drum				
2021	8	Red Drum				

FY21 Fishing Year (Sept 1, 2020 - Aug 31, 2021) Landings	**30,235**

*partial trip ticket landings only
***landings are confidential

Year	Month	Species	Pounds	Dealers	Trips	Average (2007-2009)
2016	1	SOUTHERN FLOUNDER	2,625	33	264	7,713
2016	2	SOUTHERN FLOUNDER	1,643	31	291	4,617
2016	3	SOUTHERN FLOUNDER	9,260	58	915	23,512
2016	4	SOUTHERN FLOUNDER	10,558	72	628	68,389
2016	5	SOUTHERN FLOUNDER	24,522	90	821	122,514
2016	6	SOUTHERN FLOUNDER	44,952	100	1,242	154,090
2016	7	SOUTHERN FLOUNDER	43,574	102	1,132	170,387
2016	8	SOUTHERN FLOUNDER	53,057	106	1,409	201,862
2016	9	SOUTHERN FLOUNDER	246,269	131	3,011	396,301
2016	10	SOUTHERN FLOUNDER	280,689	117	2,181	781,717
2016	11	SOUTHERN FLOUNDER	182,768	102	1,479	392,150
2016	12	SOUTHERN FLOUNDER	14	5	5	37,303
2017	1	SOUTHERN FLOUNDER	1,677	38	122	7,713
2017	2	SOUTHERN FLOUNDER	2,758	55	215	4,617
2017	3	SOUTHERN FLOUNDER	8,254	67	874	23,512
2017	4	SOUTHERN FLOUNDER	9,591	83	787	68,389
2017	5	SOUTHERN FLOUNDER	33,105	105	1,121	122,514
2017	6	SOUTHERN FLOUNDER	74,785	115	1,904	154,090
2017	7	SOUTHERN FLOUNDER	74,879	108	1,755	170,387
2017	8	SOUTHERN FLOUNDER	102,751	116	2,364	201,862
2017	9	SOUTHERN FLOUNDER	235,915	128	2,849	396,301
2017	10	SOUTHERN FLOUNDER	548,740	142	3,971	781,717
2017	11	SOUTHERN FLOUNDER	302,286	123	2,003	392,150
2017	12	SOUTHERN FLOUNDER	166	7	8	37,303
2018	1	SOUTHERN FLOUNDER	610	14	43	7,713
2018	2	SOUTHERN FLOUNDER	1,833	34	154	4,617
2018	3	SOUTHERN FLOUNDER	2,815	43	387	23,512
2018	4	SOUTHERN FLOUNDER	8,142	74	769	68,389
2018	5	SOUTHERN FLOUNDER	18,342	90	951	122,514
2018	6	SOUTHERN FLOUNDER	42,501	105	1,407	154,090
2018	7	SOUTHERN FLOUNDER	57,273	117	1,495	170,387
2018	8	SOUTHERN FLOUNDER	72,495	121	1,916	201,862
2018	9	SOUTHERN FLOUNDER	109,125	114	1,776	396,301
2018	10	SOUTHERN FLOUNDER	363,339	109	3,062	781,717
2018	11	SOUTHERN FLOUNDER	226,832	89	1,352	392,150
2018	12	SOUTHERN FLOUNDER	471	5	5	37,303
2019	1	SOUTHERN FLOUNDER	524	25	74	7,713
2019	2	SOUTHERN FLOUNDER	558	23	69	4,617
2019	3	SOUTHERN FLOUNDER	1,412	44	216	23,512
2019	4	SOUTHERN FLOUNDER	5,966	66	448	68,389
2019	5	SOUTHERN FLOUNDER	36,666	92	1,038	122,514
2019	6	SOUTHERN FLOUNDER	61,035	109	1,437	154,090
2019	7	SOUTHERN FLOUNDER	59,404	109	1,554	170,387
2019	8	SOUTHERN FLOUNDER	95,588	109	1,778	201,862
2019	9	SOUTHERN FLOUNDER	51,734	59	551	396,301
2019	10	SOUTHERN FLOUNDER	327,291	119	2,333	781,717
2019	11	SOUTHERN FLOUNDER	159,595	58	537	392,150
2020	3	SOUTHERN FLOUNDER	***	1	1	***
2020	4	SOUTHERN FLOUNDER	***	1	2	***
2020	8	SOUTHERN FLOUNDER	***	2	4	***
2020	9	SOUTHERN FLOUNDER	68,981	17	668	396,301
2020	10	SOUTHERN FLOUNDER	18,768	4	131	781,717

*2020 data are preliminary. 2016-2019 data are complete.

***data are confidential

SMALL MESH GILL NET RULES MODIFICATION

SMALL MESH GILL NET RULE MODIFICATIONS MEMO

SMALL MESH GILL NET RULE MODIFICATIONS INFORMATION PAPER

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ROY COOPER
Governor

MICHAEL S. REGAN
Secretary

STEPHEN W. MURPHEY
Director

October 26, 2020

MEMORANDUM

TO: N.C. Marine Fisheries Commission

FROM: Steve Poland, Executive Assistant for Councils
Kathy Rawls, Section Chief, Fisheries Management

SUBJECT: Small Mesh Gill Net Information Paper

Issue

The Marine Fisheries Commission requested that information be provided on potential rule modifications for small mesh gill nets in coastal waters. An information paper is included in the meeting briefing materials that summarizes available information on the small mesh gill net fishery, current management of the fishery under rule and proclamation, and presents issues and options to address concerns with survival of bycatch, management of quota managed species, user conflicts, and simplification of regulations. These issues and options are presented for consideration by the Commission for further exploration and potential rule changes.

Action Needed

Input is needed on the scope and suitability of the identified issues and options for further development. Additionally, the Marine Fisheries Commission should provide input on the potential timeline and prioritization of any rule modifications and/or actions taken through proclamation in response to this review of small mesh gill net regulations.

Overview

Subsequent to a motion passed by the Commission at the February 2020 business meeting endorsing the North Carolina Division of Marine Fisheries and Department of Environmental Qualities' initiative to pursue a comprehensive review of small mesh gillnet rules and management measures, the Division established an internal Gillnet Work Group to review rules and regulations for the fishery and identify potential rule modifications for the commission to consider. The work group reviewed and summarized available data on the characteristics of the small mesh fishery including typical gear configurations, species targeted, seasonality of catch, bycatch concerns with the gear, and identified four potential issues to address the aforementioned concerns.

Issues identified by the Gillnet Work Group include:

- Implement yardage limits for the small mesh gillnet fishery
- Adjust 'attendance' time and area requirements
- Implement set and retrieval time and setback/area restrictions
- Increase the minimum mesh size

A range of options were developed for each issue that attempt to address some or all of the concerns identified by the Department and the Commission, depending on the suite of options selected. This is not an exhaustive list of potential actions the Commission can consider, rather it includes a range of potential actions that may offer varying degrees of success.

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Small Mesh Gill Net Rule Modifications Information Paper

Nov. 3, 2020

I. ISSUE

The estuarine small mesh gill net fishery in North Carolina is managed and regulated by North Carolina Fishery Management Plans (FMPs) and numerous North Carolina Marine Fisheries Commission (MFC) rules and North Carolina Division of Marine Fisheries (DMF) proclamations. Over time, the rules and proclamations that implement the small mesh gill net requirements have become overly complex and need to be streamlined. There are also concerns about biological impacts from the use of small mesh gill nets. The primary issues to be addressed concern the streamlining and simplification, where possible, of all rules that directly or indirectly regulate small mesh gill nets, reduction and increased survival of bycatch, greater flexibility with constraining harvest of quota managed fisheries, and to the greatest extent practical reducing conflict between gill net users and other stakeholders.

II. ORIGINATION

The Secretary of the Department of Environmental Quality and the DMF director.

III. BACKGROUND

North Carolina General Statutes authorize the MFC to adopt rules for the management, protection, preservation, and enhancement of the marine and estuarine resources within its jurisdiction (G.S. 113-134; G.S. 143B-289.52). The MFC has authority to adopt FMPs and the DMF is charged with preparing them (G.S. 113-182.1; G.S. 143B-289.52). Further, the MFC may delegate to the DMF director in its rules the authority to issue proclamations suspending or implementing MFC rules that may be affected by variable conditions (G.S. 113-221.1; G.S. 143B-289.52). Variable conditions include compliance with FMPs, biological impacts, bycatch issues, and user conflict, among others (15A NCAC 03H .0103). The estuarine gill net fishery in North Carolina is managed and regulated by FMPs and numerous MFC rules and DMF proclamations. Rules are periodically amended to implement changes in management goals and strategies for various fisheries and are the primary mechanism for implementing FMPs under the Fisheries Reform Act of 1997 (FRA).

In recent years, modifications to gill net management resulting from the adoption of FMPs or other circumstances have largely been implemented through the DMF director's existing proclamation authority, not through rulemaking. This is primarily due to the need to implement management changes in a timely fashion and to accommodate variable conditions. Over time, this has resulted in incongruent restrictions between rules and proclamations. Additionally, many of the rules related to small mesh gill nets were first developed prior to the FRA and have not been thoroughly considered with the addition of more recent rules developed through the FMP process.

The aforementioned circumstances have created a patchwork of small mesh gill net restrictions spanning many rules and proclamations, contributing to stakeholder confusion and administrative burden. This paper proposes options for streamlining many of the restrictions on small mesh gill nets by codifying many of the management measures found in proclamations into rule and modifying existing rules to better represent current fishing practices and management goals. The primary issues to be addressed concern the streamlining and simplification, where possible, of all rules that directly or indirectly regulate small mesh gill nets, reduction and increased survival of bycatch, greater flexibility with constraining harvest of quota managed fisheries, and to the greatest extent practical reducing conflict between gill net users and other stakeholders.

The estuarine small mesh gill net fishery is a multi-species fishery that operates year-round. The species targeted and the type of gill net used varies by season and area (NCDMF 2018). Small mesh gill nets are used to harvest many commercially valuable estuarine finfish species by using a variety of net configurations with mesh sizes specific to the intended target species. Multiple species are landed during a single trip; however, the target species usually dominates the catch (NCDMF 2008). In North Carolina, gill nets are restricted to a minimum stretched mesh size of 2.5 inches inside stretched mesh (ISM) (15A NCAC 03J .0103 (a)). The DMF categorizes gill nets with ISM from 2.5 to less than 5 inches as small mesh (Daniel 2013). Although the rule uses "mesh length" and not "mesh size", their meanings are identical for the purpose of this document; this helps to demarcate the discussion of "mesh size" from

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"net length" throughout the document. Small mesh gill nets are generally classified into three categories based on how the net is deployed and fished: set gill nets, runaround gill nets, and drift gill nets (Figure 1; Table 1) (Steve et al. 2001). For the purpose of this document, "set" gill nets, or "set nets", includes anchored, fixed, and stationary nets.

Set nets (Figure 1a) are the predominate gill net method used in North Carolina. They are kept stationary with the use of anchors or stakes attached to the bottom or attached to some other structure attached to the bottom, at both ends of the net (15A NCAC 03I .0101). Set nets can be further classified as sink or float gill nets (Steve et al. 2001). A sink gill net fishes from the bottom up into the water column a fixed distance by having a lead line (bottom line) heavy enough to sink to the bottom. Depending on the height of the net and the depth of the water, the float line (top line) may or may not be submerged below the surface of the water. A float gill net may fish the entire water column by having the top line with buoys sufficient for floating on the surface of the water, or a portion of the water column depending on the depth of the net (number of meshes deep). Set nets are deployed by dropping one end of the net and running out the rest of the length of net usually in a line. Once deployed, soak times for fishing set nets vary depending on factors such as target species, water temperature, season, waterbody, and regulations (NCDMF 2018).

A runaround gill net is an actively fished gear used to encircle schools of fish (Figure 1b). They are deployed with a weight and a buoy at one end that enables the rest of the net to be fed out, creating a closed circle around the school of fish due to the vessel's path. Runaround gill nets tend to be deep nets capable of fishing the entire water column. Mesh sizes and net lengths vary depending on the size of the targeted species (Steve et al. 2001). Another form of runaround gill net is the strike net or drop net. Rather than deploying the net in a circle, the net is set parallel to shore, often with one end anchored to the bank. Once the net is set, the boat is driven between the net and the shore to drive fish into the net (NCDMF 2018). Soak times for all types of runaround gill nets are almost always an hour or less.

Drift gill nets are unanchored, non-stationary nets that are actively attended (i.e., remain attached to the vessel or the fishing operation remains within 100 yards of the gear) (Figure 1c) and tend to have shorter soak times than set nets. They are constructed with lighter lead lines to allow for the net to drift with the current. The small mesh drift gill nets currently employed in North Carolina estuaries are primarily used to target Spanish mackerel and bluefish in Pamlico Sound. This gear can also be used to target spot (as a sink net) and striped mullet (typically fishing the entire water column) in areas primarily from Core Sound and south (Steve et al. 2001).

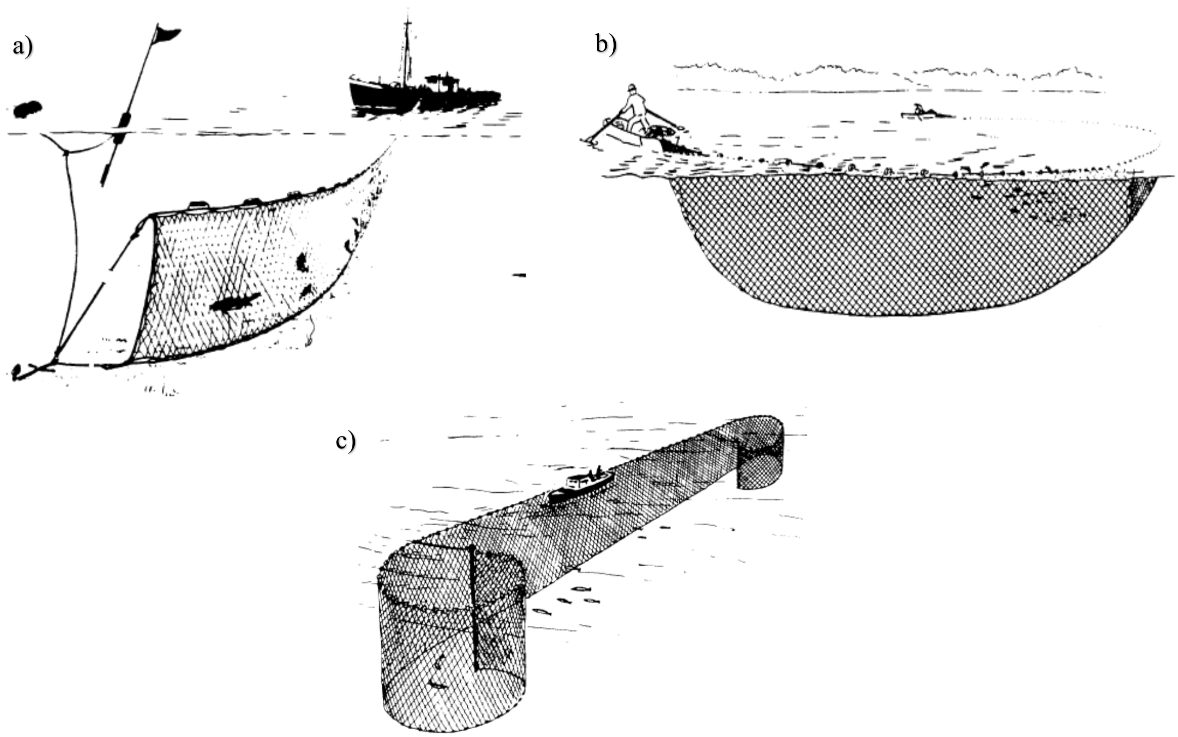

Figure 1. Illustrations of (a) set, (b) runaround, and (c) drift gill nets extracted from Steve et al. (2001).

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Table 1. Small mesh gill net gear categories with descriptions and capture method descriptions.

Small Mesh Gill Net Gear Categories	Sub-Categories	Gear Description	Capture Method
Anchored/Fixed/ Stationary/Set	Sink	Attached to bottom or some other structure by anchors or stakes at both ends. Sink nets are fished from the bottom up into the water column.	Passively Fished - For both sink and float set nets the gear is left in place for a period of time. Fish, if appropriately sized, swim into the net and are gilled.
	Float	Attached to bottom or some other structure by anchors or stakes at both ends. Float nets are fished from the top down into the water column. Depending on target species nets fish part of the water column or the entire water column.	
Runaround	Circle	Attached to the bottom at one end. Once the end is set, the rest of the net is then fed out of a boat creating a circle, and meeting back at the original set point. Generally, these nets fish the entire water column.	Actively Fished - Used to encircle a school of fish. Primary target species for this gear is striped mullet.
	Strike; Drop	Attached to the bottom at one end. Deployed along shore with the terminal end finishing at another point along the shore. The boat is driven into the blocked section to "drive" the fish into the net and are then retrieved.	Actively Fished - Used to corral or intercept a school of fish and then immediately retrieve. Primary target species for this gear is striped mullet, and spotted seatrout to a lesser extent.
Drift		Attached to boat or free-floating with close attendance. Lighter leadlines and no anchors allow the net to drift. Depending on target species and water depth, nets fish part of the water column or the entire water column. Primarily used in Pamlico Sound to target Spanish mackerel and bluefish.	Actively Fished - Drift with the water current with continuous attendance.

The following analysis and information are presented to characterize the small mesh gill net fishery in North Carolina relative to time, area, configuration, and species composition of the harvested and discarded catch:

Methods

Information specific to North Carolina's estuarine gill net fishery was gathered from three DMF sampling programs briefly described below:

N.C. Trip Ticket Program

The N.C. Trip Ticket Program began in 1994. This program requires licensed commercial fishermen to sell their catch to licensed DMF fish dealers, who are then required to complete a trip ticket for every transaction. Data collected on trip tickets include gear type, area fished, species harvested, and total weights of each individual species. Information recorded on trip tickets for gear type and characteristics is self-reported by the dealer. This information may be verified by DMF fish house staff after the fact, but the potential exists that some trips may be mischaracterized by dealers. In 2004, trip tickets included mesh size categories for gill nets: small mesh = <5 inch ISM, and large mesh = $\geq$5 inch ISM.

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However, the use of this new field was not prevalent until about 2008 because dealers were still using old trip tickets they had on hand.

Commercial Fish House Sampling

Commercial fishing activity is monitored through fishery dependent (fish house) sampling. Sampling occurs dockside as fish are landed. Commercial fishermen and/or dealers are interviewed by DMF staff, and the catch is sampled. Samplers collect data on location fished, effort (soak time, net length, etc.), gear characteristics (net type, net depth, mesh size, etc.), and the size distribution of landed species.

Commercial Observer Program

On board observations of commercial estuarine gill nets, primarily set nets, occur through Program 466. Observers collect data on effort (soak time, net length, etc.), location fished, gear characteristics, and the size and fate (harvest, discard, etc.) of captured species. The Observer Program was born out of the need to estimate incidental takes of protected species such as sea turtles and Atlantic sturgeon in estuarine set nets per the DMF's Endangered Species Act Section 10 Incidental Take Permits (National Marine Fisheries Service [NMFS] 2013, 2014). As a result, observations of runaround or drift gill nets are rare.

Data from 2015 to 2019 for these three programs were used to characterize North Carolina's estuarine small mesh gill net fisheries. For trip ticket data, the species of highest abundance in landings was considered the target species for each trip. Using the presumed small mesh targeted species, the trip was then defined as either small mesh or large mesh. Species commonly targeted and landed from small mesh gear were retained for further characterization. Basing analysis on presumed targeted species allows for results that describe the gear parameters associated with each species (see NCDMF 2008 for further description of methodology). Once a target species was defined for all trips, the method of fishing (set net, runaround gill net, or drift gill net), mesh size, and net length were characterized based on available fish house sampling and observer data from 2015 through 2019 for each of the target species. Because there were no observer trips for runaround or drift gill nets, gear characteristics for those fisheries were based solely on data collected from fish house sampling. For this analysis, species targeted with large mesh gill nets (>5 inch ISM) were excluded and species targeted with small mesh gill nets (<5 inch ISM) were retained. Fishing effort and gear characteristics were also examined across management units defined in the DMF's ITP for sea turtles (Figure 2) (Byrd et al. 2020). The delineation of management units (A, B, C, D1, D2, and E) was based on three primary factors: similarity of fisheries and management; extent of known protected species interactions in commercial gill net fisheries; and unit size and corresponding ability to monitor fishing effort (Daniel 2013).

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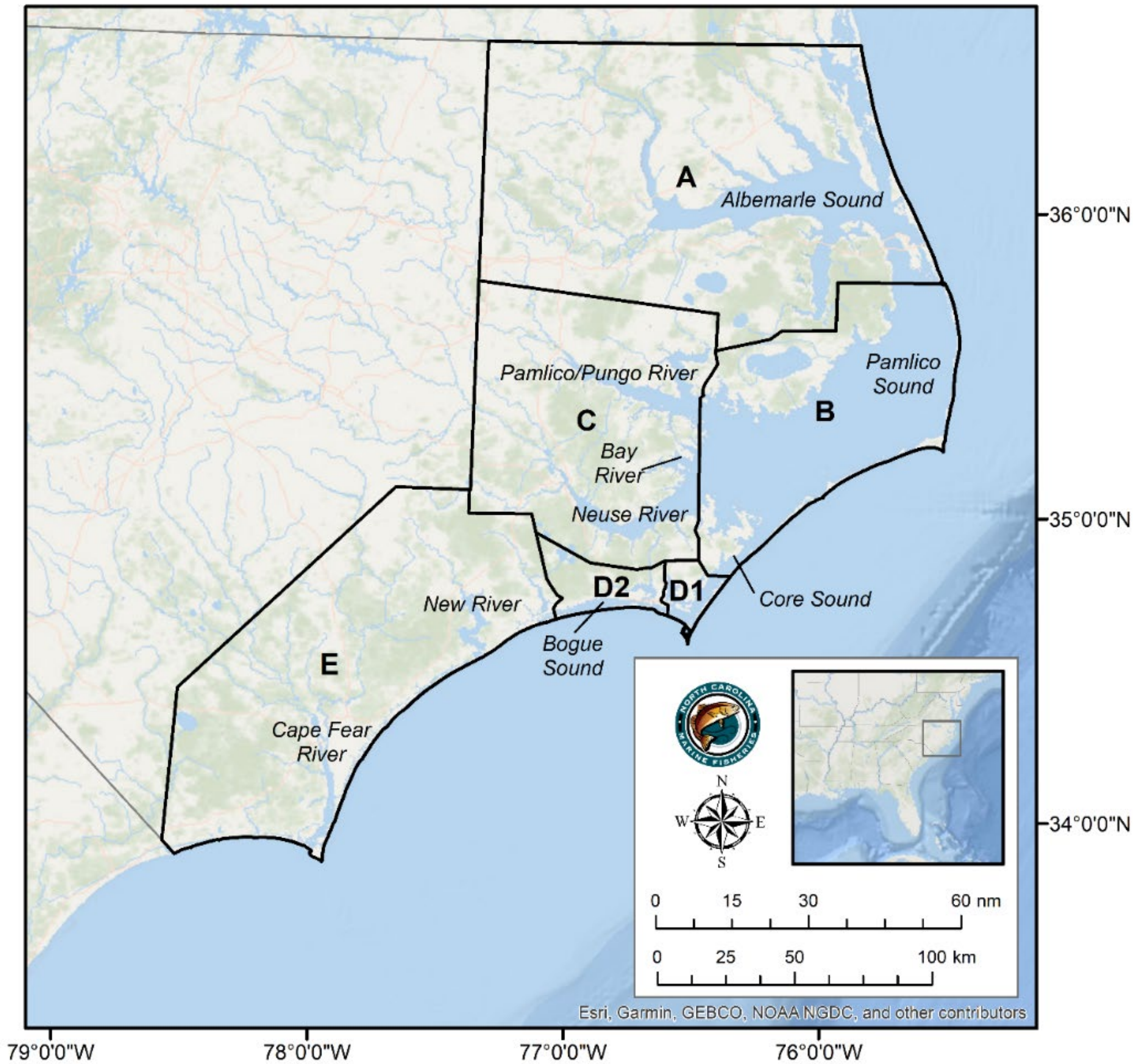

Figure 2. Locations of management units (A, B, C, D1, D2, and E) outlined in DMF's Endangered Species Act Section 10 Incidental Take Permit for sea turtles.

Results

Set Nets

Although the number of species encountered in set nets is diverse, over 99% of trips targeted at least one of 10 primary species (Table 2). These include the following, in order of magnitude: bluefish, striped mullet, spotted seatrout, Atlantic menhaden, spot, white perch, Spanish mackerel, hickory shad, weakfish, and sea mullet (kingfish spp.). The most common mesh size used for these target species was 3.25 inch ISM and mesh sizes generally ranged from 3.0 to 3.5 inch ISM. Exceptions include smaller mesh sizes (≤2.88 inch ISM) employed for gill nets targeting weakfish and sea mullet. The average yards of gill net fished per trip was highest for Spanish mackerel (1,643 yards) compared to less than 1,000 yards for all other target species. Maximum yards reported for a trip was typically between 2,000 and 3,000 yards for most species. Average yards fished was generally consistent across management units with some higher averages in management units B and D depending on target species (Figure 2; Table 3).

Seasonality and area fished for set nets varies by target species (Figure 3). Bluefish trips occurred commonly in Pamlico Sound and Core Sound with trips peaking in spring. Striped mullet set net trips occurred primarily in

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Albemarle Sound and Pamlico Sound. Although these trips occurred year around, they peaked in the fall. Targeted spotted seatrout trips occurred in all regions with the highest number of trips in the Pamlico, Pungo and Neuse River areas. Spotted seatrout trips peaked in the fall and early winter. Set nets for Atlantic menhaden were most common in Pamlico and Albemarle Sounds peaking in March and April. Spot trips primarily occurred from Core Sound and south with a sharp seasonal peak in October. White perch occurred in northern areas led by trips in the Albemarle Sound in early spring. Spanish mackerel set net trips occurred primarily in Pamlico Sound during the summer. Hickory shad trips commonly occurred in the Pamlico Sound and Albemarle Sound. This fishery was seasonal, peaking from January to March. Weakfish trips occurred primarily in Pamlico Sound from fall through spring. Sea mullet trips occurred primarily from Pamlico Sound, Core Sound and south. The trips peaked during spring and again during fall.

Table 2. Number of small mesh (<5 inch ISM) set net trips in N.C. estuarine waters using data from the N.C. Trip Ticket Program (n=34,249) by target species with associated gear characteristics from fish house sampling and observer programs during 2015-2019. Two modal mesh sizes (the mesh sizes most often observed) are provided when differences exist between fish house sampling and observer programs. Species are listed in order of magnitude (Percent of total trips).

Species	Trips	Avg/ Yr	Per-cent	Cum. Percent	Modal Mesh	Avg Yds	Max Yds
Bluefish*	8,035	1,607	23	23	3.0 / 3.25	925	3,000
Striped mullet	5,399	1,080	16	39	3.25 / 3.5	575	1,900
Spotted seatrout	4,483	897	13	52	3.5	706	3,190
Atlantic menhaden	4,089	818	12	64	3.0 / 3.25	743	2,500
Spot	3,269	654	10	74	3.0 / 3.25	659	3,200
White perch	3,215	643	9	83	3.25 / 3.5	598	2,500
Spanish mackerel*	2,114	423	6	89	3.12	1,643	2,000
Hickory shad	1,939	388	6	95	3.25 / 3.5	783	2,100
Weakfish	1,201	240	3	98	2.88 / 3.25	937	2,500
Sea mullet	505	101	1	100	2.62 / 3.0	740	1,200

*Some trips for bluefish and Spanish mackerel may be mischaracterized as set net trips when they were actually driftnet trips, skewing the average and maximum yards reported. See *Commercial Fish House Sampling* description in the Methods section for more information.

Table 3. Average yards fished per small mesh (<5 inch ISM) set net trip by target species across gill net management unit during 2015-2019. See map in Figure 1 for locations of management units (MU).

Species	MU-A	MU-B	MU-C	MU-D	MU-E
Bluefish	876	975	350	909	356
Striped mullet	621	540	486	577	505
Spotted seatrout	725	811	667	597	955
Atlantic menhaden	528	814	767	467	.
Spot	.	.	1,150	622	501
White perch	658	701	425	.	.
Spanish mackerel	.	1,643	.	.	.
Hickory shad	849	979	543	1,675	.
Weakfish	.	820	.	1,228	500
Sea mullet	.	1,200	.	625	.

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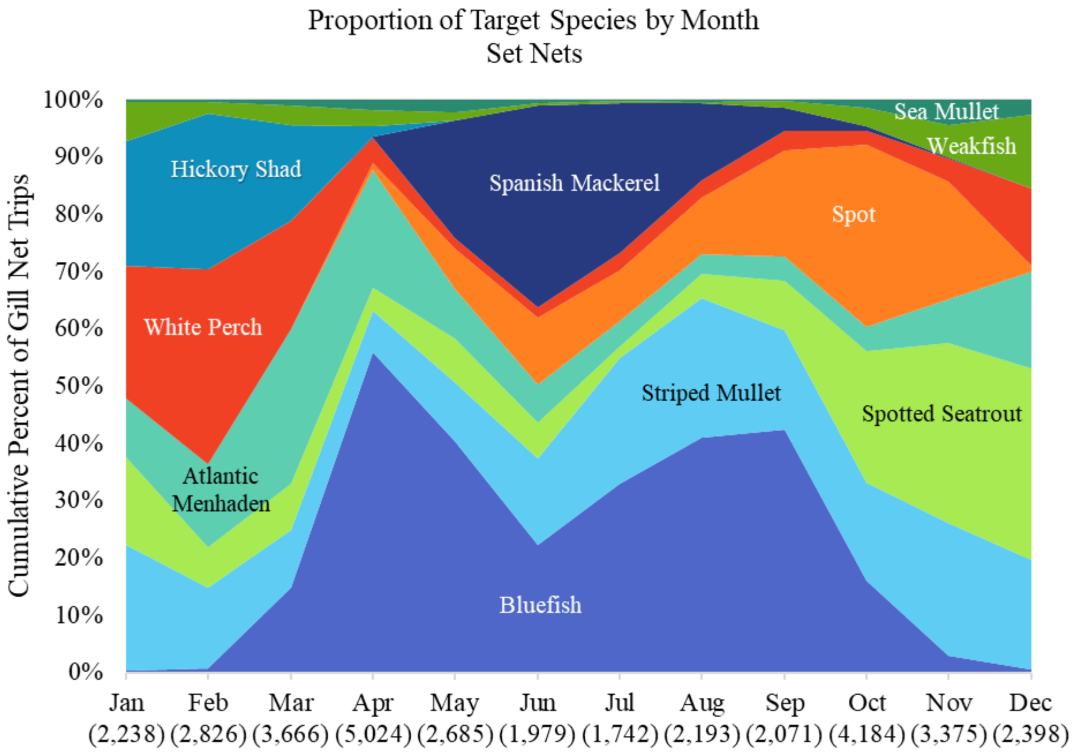

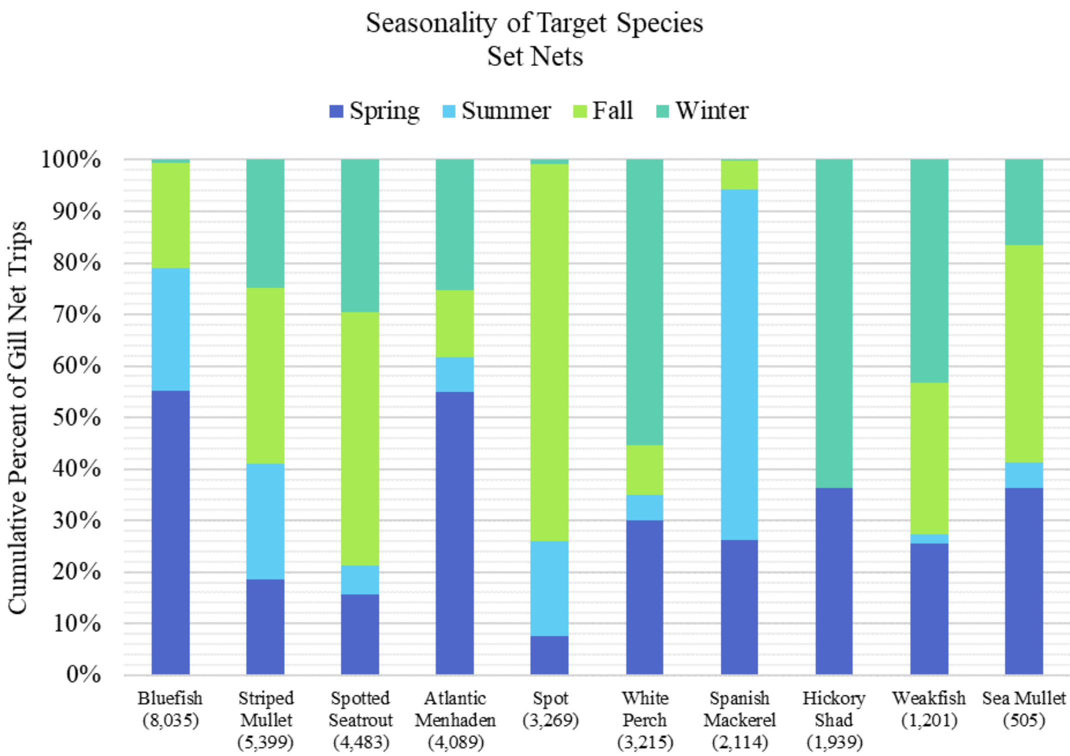

Figure 3. Percentage of set net trips for each of the 10 primary target species across months (top) and seasons (bottom) in N.C. estuarine waters during 2015-2019. Total trips per month or species are shown in parentheses under the x-axis labels.

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Runaround Gill Nets

Runaround gill nets are commonly deployed throughout the year and across all coastal waters of North Carolina. The catch from runaround gill nets is more species-specific than from set nets. This gear usually targets striped mullet, spotted seatrout, and, to a lesser extent, spot and bluefish (Table 4). Generally, the nets are deployed on fish that are visually spotted (i.e., striped mullet) or in areas specific to a species (i.e., spotted seatrout). Mesh sizes differ according to the target species. During 2015-2019, three target species (striped mullet, spotted seatrout, and spot) accounted for 87% of all runaround gill net trips. The modal mesh size was 4 inch ISM for striped mullet, 3.5 inch ISM for spotted seatrout, and 2.8 inch ISM for spot. Although modal mesh size was the most commonly encountered for a species, mesh size used for a given species such as striped mullet varied based on the season and market (i.e., smaller mesh sizes for the bait mullet fishery and larger mesh sizes for the roe mullet fishery). Average net lengths generally ranged from 400 to 500 yards, but there was high variability with maximum net lengths ranging from 700 to 3,000 yards, depending on species (Table 4). There was little variability in average net length among areas.

For runaround gill net trips, seasonality and area fished varied by target species (Figure 4). Striped mullet were targeted in all areas, but primarily in Pamlico Sound and Core/Bogue sounds with fishing increasing in late summer and peaking in the fall (October and November). Spotted seatrout were most commonly targeted with runaround gill nets in the Pamlico, Pungo, Bay, and Neuse rivers. Targeted trips increased in October and peaked in November before diminishing through the winter. The runaround spot fishery was most common in the rivers, Core Sound, and southern portions of the state. Effort was high during June through October with the traditional spot fishery peaking in October. Bluefish are most commonly targeted with runaround gill nets in Pamlico and Core/Bogue sounds with peak trips occurring in April.

Table 4. Number of small mesh (<5 inch ISM) runaround gill net trips in N.C. estuarine waters using data from the N.C. Trip Ticket Program (n=17,548) by target species with associated gear characteristics from fish house sampling and observer programs during 2015-2019. Species are listed in order of magnitude (Percent of total trips).

Species	Trips	Avg/Yr	Per-cent	Cum. Percent	Modal Mesh	Avg Yds	Max Yds
Striped mullet	9,232	1,846	53	53	4.0	412	1,250
Spotted seatrout	4,611	922	26	79	3.5	493	1,150
Spot	1,434	287	8	87	2.8	380	700
Bluefish	508	102	3	90	3.3	746	3,000
Others(n=20)	1,763	353	10	100	3.3	580	1,400

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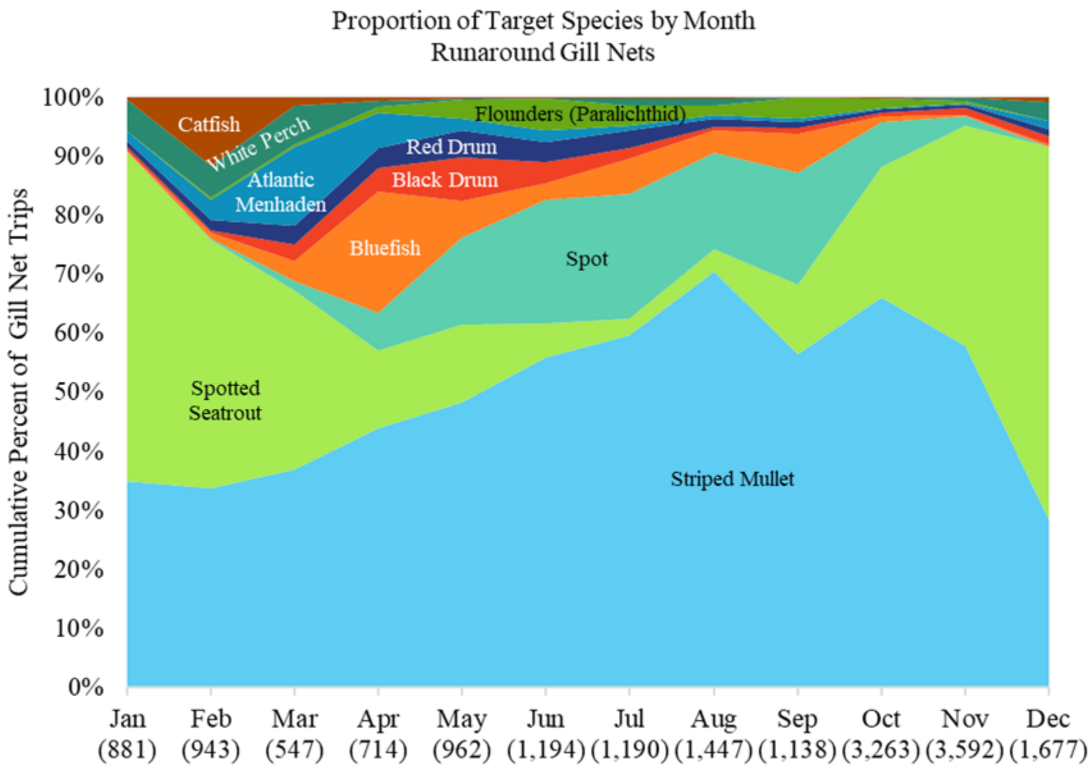

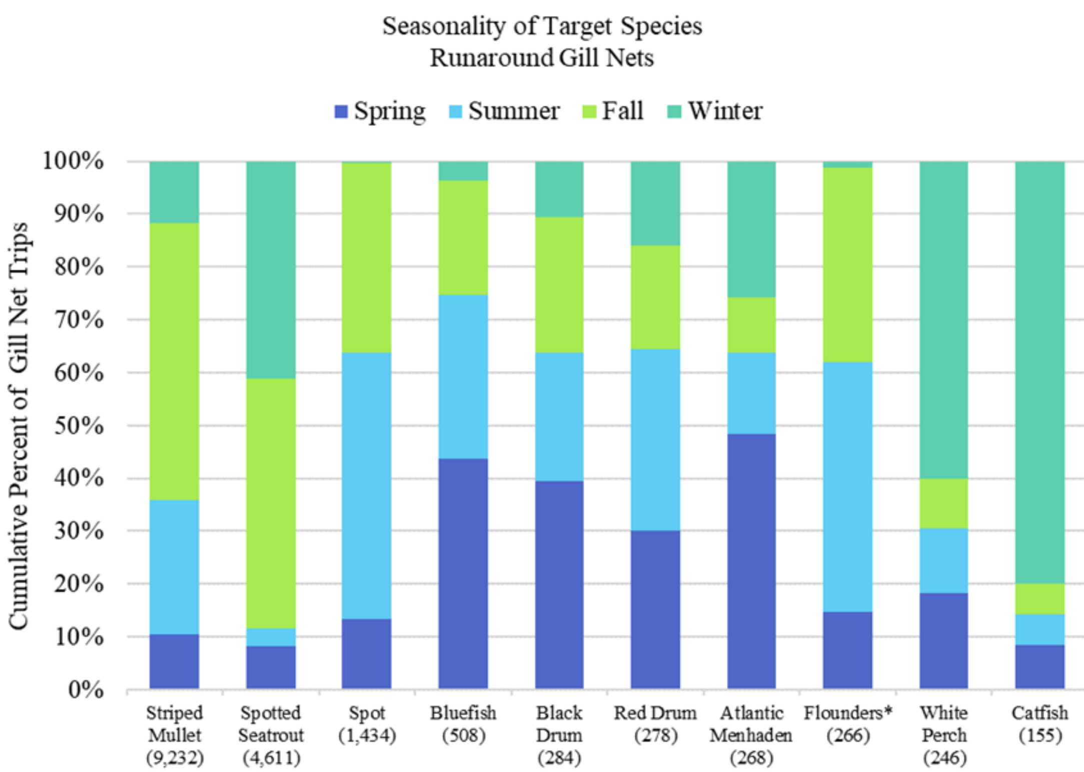

Figure 4. Percentage of runaround gill net trips for each of the ten primary target species across months (top) and seasons (bottom) in N.C. estuarine waters during 2015-2019. Total trips per month or species are shown in parentheses under the x-axis labels. An asterisk (*) indicates Paralichthid founders.

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Drift Gill Nets

The small mesh drift gill net fishery occurs almost entirely in Pamlico Sound (Figure 5) and is dominated by trips targeting Spanish mackerel and to a lesser extent bluefish and spot (Table 5). Like the runaround gill net fishery, the drift gill net fishery is highly species selective due to the areas fished, season fished, and mesh sizes used. The modal mesh size used to target Spanish mackerel and bluefish was 3.5 inch ISM, while modal mesh size used to target spot was 2.9 inch ISM. Average yards fished per trip was 1,981 yards for Spanish mackerel and 1,820 yards for bluefish. Maximum yards fished for both Spanish mackerel and bluefish was 3,000 yards.

The Spanish mackerel and bluefish drift gill net fisheries occur almost entirely in Pamlico Sound with the Spanish mackerel fishery occurring from May through September and the bluefish fishery occurring throughout the summer and peaking in August (Figure 5). Although bluefish is a major species captured in this fishery, its occurrence is closely tied to trips targeting Spanish mackerel. The spot drift gill net fishery occurs almost entirely in the southern waters of the state, primarily in October and November. The drift gill net fishery for striped mullet primarily occurs in Pamlico Sound and Core/Bogue sounds south. Striped mullet are targeted in the late spring/early summer for bait, and in the fall for roe. Although the sample size is low, average mesh size in the spring from trips landing striped mullet is smaller than in the fall. Anecdotal reports from fishermen lend additional support to these observations.

Table 5. Number of small mesh (<5 inch ISM) drift gill net trips with associated gear characteristics by target species in N.C. estuarine waters during 2015-2019.

Species	Trips	Avg/Yr	Percent	Cum. Percent	Modal Mesh	Avg Yds	Max_ Yds
Spanish mackerel	644	129	52	52	3.5	1,981	3,000
Bluefish	207	41	17	68	3.5	1,820	3,000
Spot	202	40	16	84	2.86	933	1,400
Striped mullet	111	22	9	93	3	417	500
Others (n=6)	86	17	7	100	3.88	900	1,900

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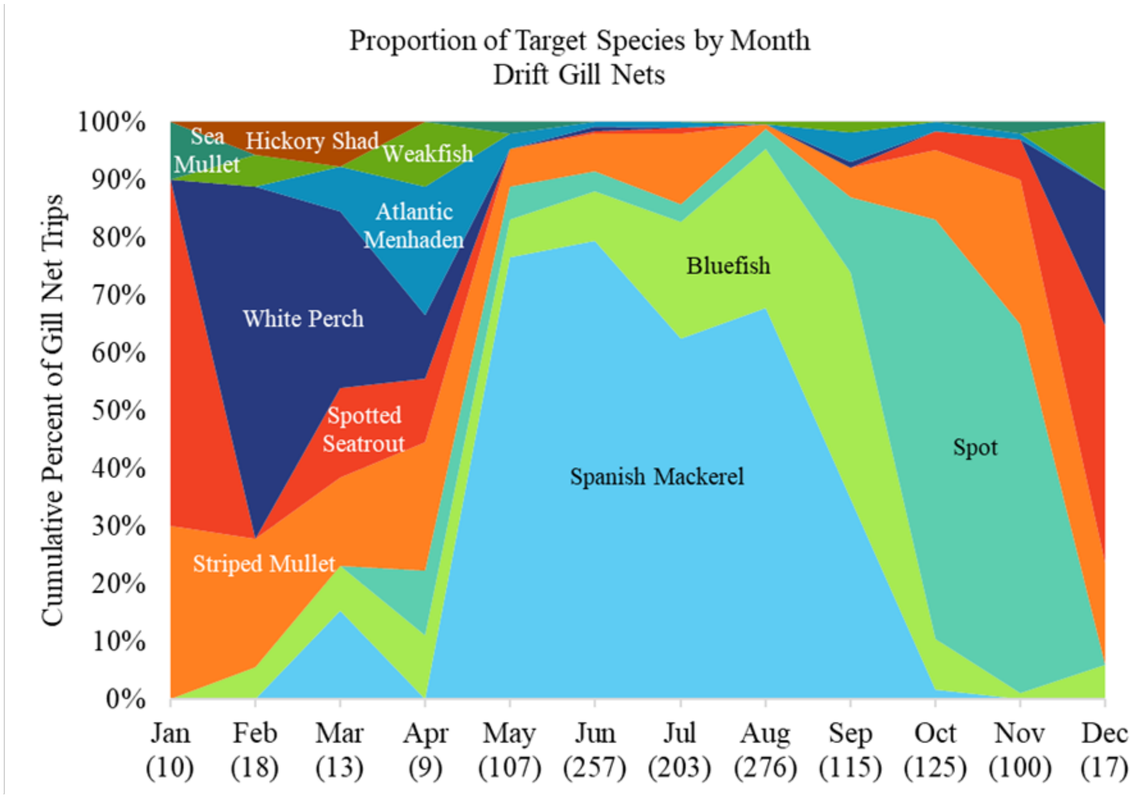

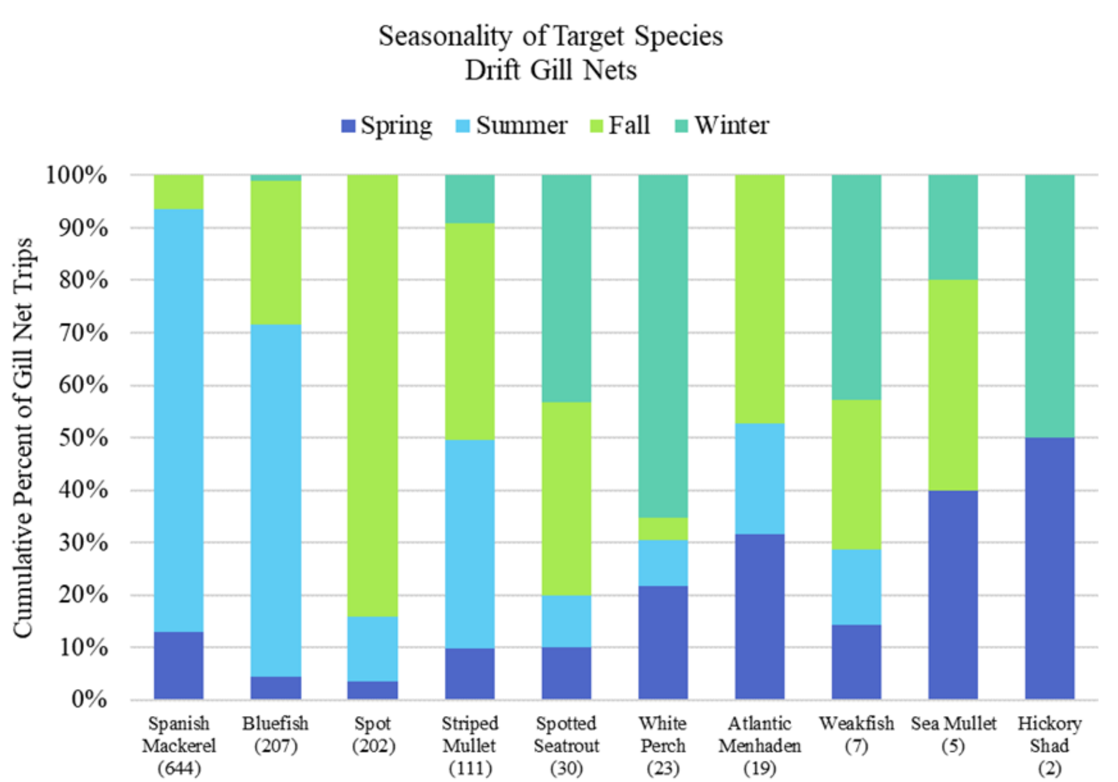

Figure 5. Percentage of drift gill net trips for each of the 10 primary target species across months (top) and seasons (bottom) in N.C. estuarine waters during 2015-2019. Total trips per month or species are shown in parentheses under the x-axis labels.

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Measures used to address bycatch

Numerous gill net restrictions have been implemented over the years, either through proclamation or rule, following state FMPs that have identified bycatch as a source of mortality impeding stock growth and productivity. These restrictions have included minimum setbacks from shore for set nets, tie downs to limit the amount of the water column fished by the gear, and either seasonal or area specific required attendance and closures. Recommendations for reducing bycatch of state managed species were developed through the FMP process and in general, addressed species specific concerns to reduce mortality at critical life history stages and/or sub-legal sizes. These measures were informed by studies that enumerated the frequency that target and non-target species were caught and discarded from the nets, their subsequent survival, and gear parameters and set characteristics of the nets typically fished.

As part of the original FRA, G.S. 143B-289.52 charged the MFC to establish guidance criteria as to the contents of FMPs. The MFC adopted the "Guidelines for North Carolina Fishery Management Plans", which set a standard for FMPs to design management measures that minimize waste of fishery resources, including both target and bycatch species. The Red Drum FMP (NCDMF 2001) and subsequent amendment (NCDMF 2008) identified non-harvest loss of red drum as a key factor contributing to the uncertainty of stock status of the species. While non-harvest losses of red drum likely occur to some extent from various commercial gears, it has been well accepted that the primary non-harvest loss is likely due to the bycatch of red drum in the estuarine gill net fishery. As a result, the 2001 N.C. Red Drum FMP took measures to reduce red drum bycatch in the estuarine gill net fishery by requiring the seasonal attendance of small mesh gill nets (<5" inch ISM). The rationale for employing attendance requirements to reduce non-harvest loss is that fishermen can actively fish their gear and release red drum and other sub-legal fish quickly, reducing the chance of harm to the fish from the gear. Gill nets of this mesh size select for red drum less than 18" total length and are a significant source of the bycatch mortality, particularly in months when water temperatures are high.

Following the original FMP, North Carolina regulations required the attendance of small mesh gill nets from May 1 through October 31 in areas known to be critical for juvenile red drum. The areas where attendance is required include all primary and secondary nursery areas, areas within 200 yards of any shoreline, and the extensive area of shallow grass flats located behind the Outer Banks. An exemption to this rule lifts the attendance requirement for the region from Core Sound to the South Carolina border in October to allow for the fall spot fishery. A study conducted in Core Sound during 1999 indicated that catches of red drum during the October fall spot fishery were relatively low. All observed trips conducted during the study occurred while gill netters were fishing nets set approximately 100 yards from shore. This practice of setting nets well off the shoreline appeared to be effective at reducing the incidence of juvenile red drum bycatch in this fishery. During the same study, DMF gill nets set less than 100 yards from shore had substantially more red drum bycatch than did sets made at ≥100 yards from shore.

Amendment 1 to the Red Drum FMP further refined the gill net attendance rules based on additional data collection by the DMF to focus regulations on areas and times when mortality and interactions were highest. Major modifications included extending the attendance requirement to November 30 and reducing the distance from shore attendance requirement to 50 yards in Pamlico Sound and in the area from Core Sound and south.

IV. AUTHORITY

§ 14-4.1. Legislative review of regulatory crimes.
§ 113-134. Rules.
§ 113-182. Regulations of fishing and fisheries.
§ 113-182.1. Fishery Management Plans.
§ 113-221.1. Proclamations; emergency review.
§ 143B-289.52. Marine Fisheries Commission – powers and duties.

15A NCAC 03H .0103 PROCLAMATIONS, GENERAL
15A NCAC 03I .0102 TEMPORARY SUSPENSION OF RULES

V. DISCUSSION

To address the issues identified by the Secretary of the Department of Environmental Quality and the DMF director, four categories of options for discussion and consideration are presented below (yardage limits, attendance requirements, set time and area restrictions, and mesh size limits). These various categories of potential rule

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modifications, in combination, attempt to streamline and simplify small mesh gill net rules, address bycatch in small mesh gill nets, provide for greater flexibility with constraining harvest of quota managed species, and to the greatest extent practical reduce conflicts between gill net users and other stakeholders. Each section will discuss the aforementioned categories relative to the proposed management options.

Yardage limits

As a management tool, yardage limits can be utilized to constrain effort within a fishery to moderate removals over time. This is a common management practice for quota managed species to ensure quota is available throughout the fishing season or as long as reasonably possible. When coupled with requirements for attendance, the measure can potentially contribute to higher rates of survival of discarded fish by promoting more frequent fishing of the gear. Additionally, yardage limits have the potential to address concerns of user conflict. Simply put, less gear in the water can translate to potentially lower incidence of interaction with other fisheries. There are no yardage limits that currently exist in rule for nets < 4 inch ISM. Nets > 4 inch ISM are limited to a maximum of 2,000 yards in rule (15A NCAC 03J .0103 (b)(3)(B)) but are currently restricted to 1,500 yards by proclamation. The DMF director has authority to limit the amount of yardage through proclamation for either small or large mesh gill nets and has restricted the amount of allowable yardage for small mesh gill nets recently to 800 yards with an exception for drift gill nets in Pamlico Sound of 1,500 yards from May 1 – October 31. The exception allows for the Spanish mackerel and bluefish fisheries that primarily operate in Pamlico Sound to use more net to maintain efficiency and profitability of trips (further explained below).

Option 1 would maintain the current yardage limits for small mesh gill nets and proclamation authority for the DMF director to modify as needed. With the current yardage limits in place, issues related to dead discards and management of quota managed fisheries may have been adequately addressed. However, these yardage limits have not been in place for a full fishing year so the effect on the aforementioned issues is not yet known.

Options 2 through 9 provide for the establishment of yardage limits for small mesh gill nets statewide. The proposed yardage limits were informed by the previously summarized characterization of the small mesh gill net fishery and reasonable alternatives are proposed that mirror either the maximum or average yardages observed currently in the fishery. Additionally, options are proposed that allow for exemptions for drift gill net fisheries, to provide: greater flexibility for fisheries that may need more gear to remain viable, typically do not have a high incidence of bycatch, and/or occur in areas away from shore and other fisheries that may contribute to conflict.

Option 2 would establish a 2,000-yard limit for small mesh gill nets statewide in Internal Coastal Waters, which are all Coastal Fishing Waters except the Atlantic Ocean. This would be consistent with the large mesh limit currently in rule and provide clarity for stakeholders on the allowable yardage of net in state waters. In general, most net fisheries in the state, excluding some drift gill net fisheries, average considerably less yardage than 2,000 yards. This action is not expected to reduce the amount of total net yardage fished in the state, but will provide a "top end" for yardage where one currently does not exist in rule. It would also allow for the drift gill net fishery to continue as-is, relatively unaffected given that the average yardage of drift gill nets is less than 2,000 yards. This may constrain some trips, but there would not be a need to consider special exemptions for the fishery.

Option 3 would establish a 1,500-yard limit for all small mesh gill net fisheries in Internal Coastal Waters. This yardage limit is closer to the current statewide average for all combined small mesh gill net trips. This may affect the drift gill net fishery more than Option 2, but is still equivalent to the average amount of yardage fished and may help constrain effort and landings for the Spanish mackerel and bluefish quota managed fisheries by limiting the potential for large catches. However, this option does not reduce the amount of yardage fished in other small mesh gill net fisheries statewide, so there would be little benefit realized for the issues of reducing bycatch and user conflict.

Option 4 would establish an 800-yard small mesh gill net limit statewide in Internal Coastal Waters. This would make the state consistent with yardage restrictions currently in place through proclamation for Albemarle Sound and its tributaries, simplifying statewide regulations for the gear. However, based on stakeholder feedback the drift gill net fishery may be greatly affected by this yardage limit to the point that the viability of the fishery may be in question. Excluding the drift gill net fishery, 800 yards approximates the statewide average of net yardage fished in the small mesh gill net fishery. This would offer some benefits towards addressing issues with bycatch and user conflict, but in areas of the state south of Highway 58, the average yardage of net fished is much less.

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Option 5 would establish two yardage limits based on area, with an 800-yard small mesh gill net limit statewide North of Highway 58 in Internal Coastal Waters and a 500-yard small mesh gill net limit South of Highway 58 in Internal Coastal Waters. A 500-yard limit south of Highway 58 would more closely match the average yardage currently fished in those areas of the state, imparting the same benefits and concerns for areas north highlighted under Option 4. Also, the same concerns for the drift gill net fishery exist for this option.

The drift gill net fishery operates in large, open bodies of water generally away from areas frequented by other fisheries. This fishery does not typically interact with other net fisheries or recreational fisheries, translating into lower reports of conflict relative to set and strike net fisheries. Nets are attended when fished and non-marketable bycatch can be low. The primary targeted species of the drift gill net fishery are Spanish mackerel and bluefish; both quota managed fisheries. In general, due to the larger vessels needed to safely fish open bodies of water, higher yardages of net are typically fished to maximize profitability of the trips. Given this, Options 6 through 9 provide for exemptions for this fishery relative to statewide yardage limits described above. Options 6 and 7 allow for 1,500 yards of small mesh drift gill net from May 1 – October 31, primarily allowing for the Spanish mackerel drift gill net fishery to occur, but with yardage limits approximately equal to the average amount of yardage observed in the fishery. A 1,500-yard allowance for the Spanish mackerel drift gill net fishery still allows for the traditional fishery but may limit the amount of gear fished and potentially increase the frequency that fishermen fish their nets, leading to decreased discard mortality. However, the time period may not allow for other fisheries like bluefish or bait fisheries to seasonally operate when their targeted species are available. Options 8 and 9 allow for flexibility in providing a drift gill net yardage exception by allowing the DMF director to increase the yardage limit for drift gill nets up to 1,500 yards by proclamation and specify the area and time for this exception.

Attendance requirements

Bycatch, and minimizing waste of target and non-target species in N.C. gill net fisheries has been addressed in many FMPs. As part of FMPs for red drum (NCDMF 2001; 2008) and striped bass (NCDMF 2004; 2013), small mesh gill net (<5.0 inch ISM) attendance requirements have been implemented as a strategy to decrease dead discards of these species. “Attended” is defined in Rule 15A NCAC 03I .0101 as being in a vessel, in the water, or on the shore, and immediately available to work the gear and be within 100 yards of any gear in use by that person at all times. Attendance does not include being in a building or structure. The intent of the attendance requirement is to indirectly limit the amount of gear that can be fished and directly reduce mortality of discards and protected species. All options and discussion of attendance requirements in this section are only applicable to areas south of Albemarle Sound. Attendance requirements in Albemarle Sound are applicable to ranges of mesh sizes and do not have distance from shore qualifiers as the rest of the state does.

Small mesh gill net attendance was first implemented in Pamlico and Neuse rivers by proclamation in 1995. Expanded attendance requirements are now in rule from the Red Drum FMP for the state (15A NCAC 03J .0103) (Appendix, Figure A1). Rule 15A NCAC 03J .0103(g) and (h) state:

> (g) It is unlawful to use unattended gill nets with a mesh length less than five inches in a commercial fishing operation in the gill net attended areas designated in 15A NCAC 03R .0112(a).
> (h) It is unlawful to use unattended gill nets with a mesh length less than five inches in a commercial fishing operation from May 1 through November 30 in the Internal Coastal Waters and Joint Fishing Waters of the state designated in 15A NCAC 03R .0112(b).

Year-round small mesh gill net attendance is required in the upper portions of the rivers (Pamlico and Neuse) and within 200 yards of shore in the lower rivers (Figure 6). From May 1 through November 30 small mesh gill nets must be attended in all primary and permanent secondary nursery areas, no trawl areas, within 50 yards of shore in Pamlico and Core sounds, and all coastal waters south to the North Carolina/South Carolina state line. An exemption to this rule lifts the attendance requirement for the region from Core Sound to the South Carolina border in October to allow for the fall spot fishery. Overall, the amount of small mesh gill net effort has been reduced in areas where attendance requirements are required.

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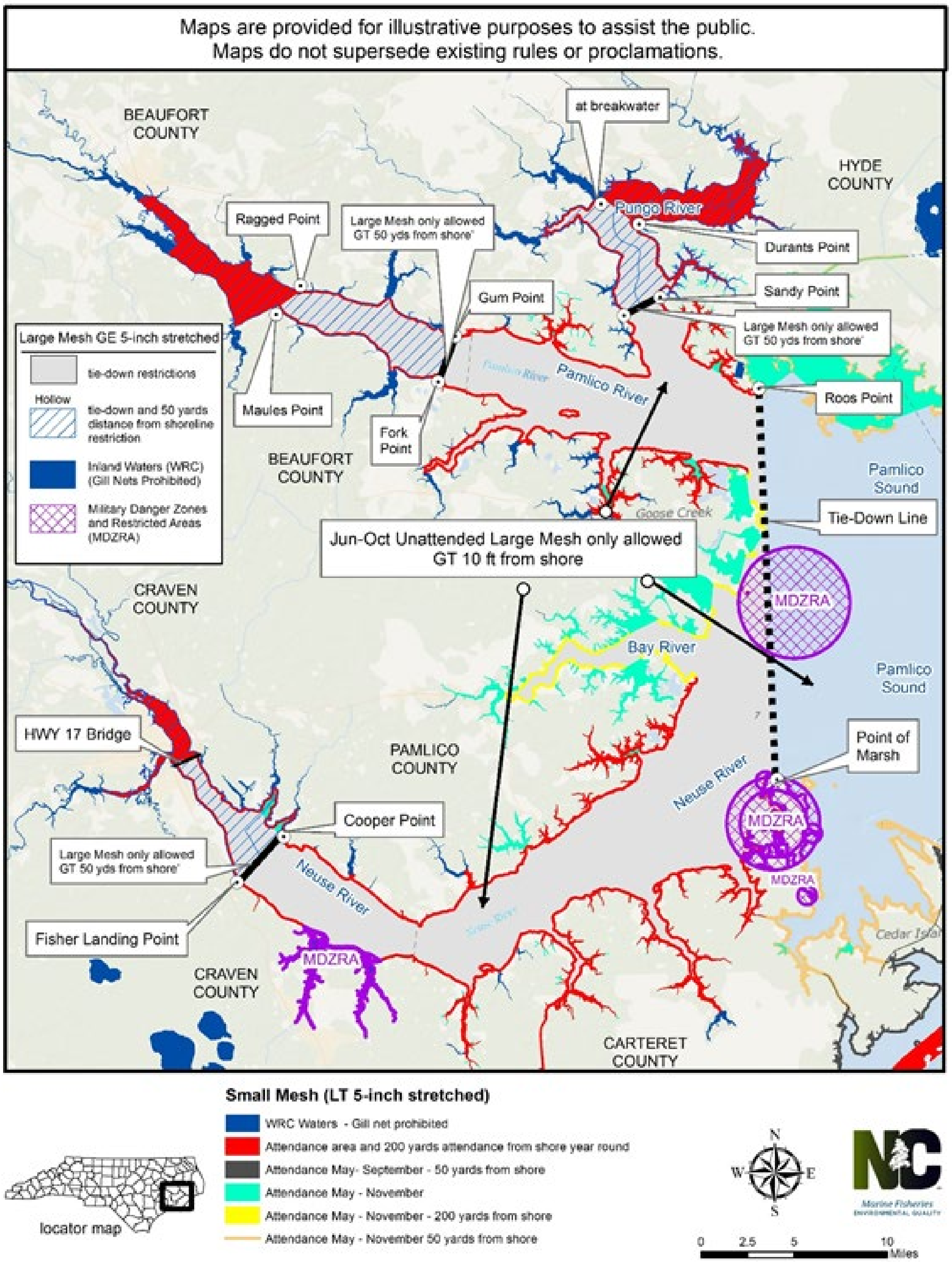

Figure 6. Gill net regulations for small and large mesh gill nets in the Pamlico, Pungo, Bay, and Neuse rivers.

Implementation of areas and seasons where small mesh gill net attendance is required was informed by analysis of best available data from onboard commercial fishery observers and fishery-independent (DMF) gill net sampling. For example, a study conducted in Core Sound during 1999 indicated catches of red drum during the October fall spot fishery were relatively low (NCDMF 2001). All observed trips conducted during the study occurred while gill netters were fishing nets set approximately 100 yards from shore, which appeared to be effective at reducing the incidence of juvenile red drum bycatch in the fishery. Fishery-independent gill nets set concurrently by the DMF caught substantially more red drum within 100 yards from shore than those set greater than 100 yards from shore. This information was used as the basis for exempting the October spot fishery in Core Sound from attendance requirements.

Fishery-independent gill net data was also used to inform decisions regarding extending attendance for small mesh gill nets within 200 yards of shore to include the area of the lower Neuse out to the mouth of the river and to modify the seasonal attendance requirement to include the period of May 1 through November 30 in all primary and permanent secondary nursery areas, no trawl areas, within 50 yards of shore in Pamlico and Core sounds, and all coastal waters south to the North Carolina/South Carolina state line (NCDMF 2008). These decisions were based on acute mortality of sub-legal red drum for each month during fishery-independent gill net sampling. Because of the rigorous process used in identifying the need for attendance requirements and reductions in effort associated with implementation of attendance requirements, regulations have largely been effective in reducing dead discards of red drum and striped bass from small mesh gill nets.

However, because of the patchwork nature of areas requiring small mesh gill net attendance and differences in seasonality of attendance requirements, the simplification of existing rules may alleviate confusion and aid in enforceability. Other attended areas are implemented via proclamation (see Option 1 below), which creates flexibility in how they are implemented but may lead to confusion. Codifying these requirements in rule would maintain consistency with how most attendance requirements are implemented and reduce potential for confusion by the fishing public.

While existing small mesh gill net requirements are likely adequate for reducing discard mortality, expansion of attendance areas, or attendance seasons, would likely lead to greater survival of discards over a broader area and time range. Requiring year-round attendance of small mesh gill nets set within 200 yards from shore statewide would create consistency in rules and possibly reduce dead discards. This measure would mostly impact areas outside of the Pamlico and Neuse rivers (year-round attendance required within 200 yards from shore in rivers; Figure 1). Year-round attendance could also be considered for areas designated in Rule 15A NCAC 03R .0112(b) (i.e., primary nursery areas, permanent secondary nursery areas, no trawl areas). This would create consistency in the timing of attendance requirements.

Increasing the area or time when attendance is required would cause some concerns about safety because of the need to remain on the water attending nets. This is of particular concern in the northern part of the state where waterbodies are larger with fewer sheltered areas. In addition, attendance requirements have been shown to reduce effort, so any additional requirements would likely further limit the small mesh gill net fishery, and potentially cause shifts to the runaround and drift gill net fisheries. The opportunity cost of trips for fishermen may increase with additional attendance requirements translating to increase effort for the same amount of fish.

Consideration could also be given to modifying the definition of attended. Currently, the requirement for attendance is being within 100 yards of the gear. Some stakeholders have pointed out that a modification in the attendance definition to allow for a greater distance from gear could impart some benefits relative to efficiency of the fishing operation. The distance requirement could be increased to increase efficiency of the fishing operation, but this is counterproductive for the overall effort examined in this document as it could allow for more gear to be fished. That said, a greater distance could provide the flexibility to fish multiple smaller shots of gill net that could be fished more quickly, offsetting the increased attendance requirements and reducing opportunity costs for fishermen overall. This type of modification may be useful in smaller waterbodies in the southern part of the state (south of Highway 58) where shorter lengths of net are used and can be more readily attended. However, this requirement could also lead to increased time in-between fishing different shots of net that could cause enforcement issues and may lead to increased dead discards. The distance threshold could be modified to require being physically in contact with the gear at all times. This modification would cause set nets to be fished more like runaround or drift gill nets and would likely limit dead discards and would be easily enforced. However, this would eliminate the ability to set multiple shots of gill net and could create unsafe fishing conditions. This modification would likely lead to extreme declines in small mesh set net effort.

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Set time and area restrictions
Set time and area restrictions for gill nets currently in rule prohibit setting nets: within 150 or 300 yards of bridge crossings in various rivers and waterbodies (15A NCAC 03J .0102; 15A NCAC 03J .0103(d)(2)); within various distances from pound nets (15A NCAC 03J .0103(d)(1)); in numerous small embayments, basins, and areas (15A NCAC 03J .0402); and in joint fishing waters of Lake Mattamuskeet and within 800 feet of Lock Number 1 on the Cape Fear River (15A NCAC 03Q .0107(2)(a); .0107(3)). Pursuant to Rule 15A NCAC 03J .0103(b), the DMF director may, by proclamation, specify the time, area, and means and methods for setting gill nets. Per proclamation M-3-2014, it has been unlawful to set gill nets in joint coastal waters from midnight on Friday to midnight on Sunday except for portions of Albemarle and Currituck sounds since Feb. 5, 2014. Additional area restrictions implemented in proclamation include prohibiting the use of gill nets near Martins Point in Currituck Sound since Dec. 2, 2016 (M-26-2016) to reduce user group conflict, and upstream of the ferry lines in the Neuse and Pamlico rivers since March 18, 2019 (M-6-2019) to fulfill a directive by the MFC pursuant to N.C. General Statute 113-221.1 (d).

Keeping the current restrictions for set time and area for small mesh gill nets would allow for the DMF director to maintain the ability to modify restrictions via proclamation, which may reduce confusion for fishermen who are familiar with the current set time and area restrictions. However, this option does not address the concerns raised with conflict between user groups in areas not covered under current rule or proclamation. By codifying the restrictions on set time and area currently in proclamation into rule, regulatory complexity could be reduced but would limit the ability of the DMF director to modify restrictions via proclamation, reducing flexibility to address variable conditions. The process for rule change is lengthy and as a result could delay changes to management strategies and could complicate the ability to implement FMPs in a timely fashion.

Further restricting the time and/or days that small mesh gill nets may be set and retrieved could potentially reduce user conflict by removing the gear from the water during times when recreational activities are highest (i.e., recreational fishing, kayaking, pleasure boating, etc. in daylight hours and on weekends). Reduced soak times may limit the number of dead discards, as well as aid in the management of quota managed species (i.e., Spanish mackerel and bluefish) by constraining landings, potentially leading to longer fishing seasons. Depending on what time nets are specified to be retrieved, the expected reductions in conflict could be diminished if the soak times extend too long into daytime hours. Conversely, if the specified retrieval time is early in the morning, safety at sea becomes an issue for fishermen travelling long distances in dark conditions to retrieve their gear on time. Restricting the time nets may be set and fished could potentially result in lost revenue from declines in effort, as well as disrupt the supply of harvest to markets.

Defining the times in specific areas that nets can be set could potentially serve as a more fine-tuned approach to address user group conflict issues with the small mesh gill net fishery. Restricting soak times in certain areas or management units could result in the same outcomes (both positive and negative) as discussed for set time restrictions. However, the area and time restrictions could be tailored to fit areas where the need to reduce user group conflict is highest. While it might be beneficial in reducing conflict, restrictions by area would result in regulatory inconsistencies across waterbodies and could create a perceived inequality among commercial fishermen who fish different areas of the state. Another option would be to prohibit the use of nets in certain areas or within a specified distance of docks or improved shorelines, regardless of the time of day. While this option could permanently reduce conflict in restricted areas, it would remove access for net fishermen from public trust waters. Also, implementing this option could result in increased localized abundance of some species if the loss of harvest by gill nets is not recouped by other gears.

Mesh size limits
Minimum mesh size for gill nets has basically gone unchanged since the 2.5 inch mesh size for all "nets" was first implemented by the Department of Conservation and Development in 1927. Minimum mesh size restrictions currently in rule make it unlawful to use gill nets with a mesh size less than 2.5 inch ISM. (15A NCAC 03J .0103 (a) (1)). The only variations are in proclamations effective in areas of the Albemarle, Currituck, Roanoke, and Croatan sounds (Management Unit A) that restrict gill net minimum mesh sizes to 3.0 inch ISM. Gill nets from 2.5 inches to less than 5.0 inches are generally considered small mesh nets.

Preliminary analysis of mesh sizes indicates that the minimum mesh size currently in rule is smaller than what fishermen are using. Gill net trips for sea mullet and spot are typically those using mesh sizes smaller than 3.0 inch ISM. The most common mesh sizes used in the small mesh fishery was 3.25 inches and mesh sizes generally ranged from 3.0 to 3.5 inch ISM (Tables 2, 4, and 5).

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Mesh size options presented include minimums of 2.625, 2.75, and 3.0 inch ISM. DMF staff reached out to multiple gill net fishermen and there was no support for increasing the minimum mesh size requirements to 3.0 inch ISM. Most of the fishermen were in support of increasing the minimum mesh size to 2.75 inch ISM because they currently use that size or larger. Some fishermen expressed concern that an increase in minimum mesh size requirements might adversely affect the sea mullet fishery in the ocean that generally uses 2.5 – 2.625 inch ISM sizes. There was considerable discussion that increasing the minimum mesh size would allow escapement of smaller spot and croaker and that sea mullet normally captured in the smaller mesh sizes would eventually “grow into” the larger mesh sizes.

Increases in minimum mesh size requirements could potentially reduce incidence of regulatory discards in some fisheries by modifying gill net selectivity. Although some catches of marketable species may decline due the change in selectivity, it is hard to know the level of impact, good or bad, this increase may have. It is likely that changes may result in both positive and negative impacts to fisheries and stocks depending on the species.

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VII. PROPOSED MANAGEMENT OPTIONS

Yardage limits

Option 1: *status quo* – no yardage limit in rule for gill nets with stretched mesh less than four inches

- \+ No rule change required
- \+ DMF director has proclamation authority under current rules to implement yardage limits.
- \+ No need for fishermen to modify current gear
- \+ No additional regulation for Marine Patrol to enforce
- \- Unlimited yardage makes controlling harvest for quota managed fisheries difficult
- \- Excessive yardage can contribute to high mortality of discarded fish and other marine organisms

Option 2: Specify that the allowable yardage of gill nets with stretched mesh less than four inches shall not exceed 2,000 yards per vessel in Internal Coastal Waters regardless of the number of individuals involved.

- \+ Establishes small mesh yardage limit above current statewide average providing minimal impact to fishermen, but constrains further expansion of small mesh gill net effort
- \+ May help constrain landings of quota managed species (Spanish mackerel and bluefish) and provide for greater fishing opportunities through extended open seasons
- \+ Would create consistency with current yardage limit for nets with stretched mesh greater than four inches
- \- Some fisheries currently use in excess of 2,000 yards and will be disproportionally affected by the yardage limit.
- \- Some fishermen may need to modify gear/vessel to comply.

Option 3: Specify that the allowable yardage of gill nets with stretched mesh less than four inches shall not exceed 1,500 yards per vessel in Internal Coastal Waters regardless of the number of individuals involved.

- \+ Uses the best available data to set the yardage limit at the current statewide average
- \+ May help constrain landings of quota managed species (Spanish mackerel and bluefish) and provide for greater fishing opportunities through extended open seasons
- \+ Is consistent with current management measures in proclamation for gill nets with stretched mesh greater than four inches
- \+ DMF director has proclamation authority under current rules to implement yardage limits less than 1,500 if needed.
- +/- Reduces the current average level of effort and provides conservation benefits by potentially increasing the frequency that attended gear is fished and thereby increasing the potential for survival of discarded fish
- +/- Areas of the state south of Hwy 58 average considerably less than 1,500 yards and will not be affected by this limit.
- \- Some fisheries currently use in excess of 1,500 yards and will be disproportionally affected by the yardage limit.
- \- Some fishermen may need to modify gear/vessel to comply.

Option 4: Specify that the allowable yardage of gill nets with stretched mesh less than four inches shall not exceed 800 yards per vessel in Internal Coastal Waters regardless of the number of individuals involved

- \+ May help constrain landings of quota managed species (Spanish mackerel and bluefish) and provide for greater fishing opportunities through extended open seasons
- \+ DMF director has proclamation authority under current rules to implement yardage limits less than 800 if needed.
- +/- Reduces the current average level of effort and provides conservation benefits by potentially increasing the frequency that attended gear is fished and thereby increasing the potential for survival of discarded fish

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+/- Changes to per-trip cash flows due to reduction of gear fished, potential increase of product quality, reduction of net needed to purchase and maintain, and increase in trip efficiency
- Most fisheries in internal waters north of Highway 58 will be affected; some may be reduced to the point that it is not feasible (i.e., drift gill net fishery).
- Some fishermen may need to modify gear/vessel to comply.

Option 5: Specify that the allowable yardage of gill nets with stretched mesh less than four inches shall not exceed 800 yards per vessel in Internal Coastal Waters north of Highway 58 and 500 yards south of Highway 58, regardless of the number of individuals involved

+ May help constrain landings of quota managed species (Spanish mackerel and bluefish) and provide for greater fishing opportunities through extended open seasons
+ DMF director has proclamation authority under current rules to implement yardage limits less than 800 if needed.
+ Lesser yardage limit south of Highway 58 better reflects current yardage use in these areas and imparts some reduction in overall yardage fished.
+/- Reduces the current average level of effort and provides conservation benefits by potentially increasing the frequency that attended gear is fished and thereby increasing the potential for survival of discarded fish
+/- Changes to per-trip cash flows due to reduction of gear fished, potential increase of product quality, reduction of net needed to purchase and maintain, and increase in trip efficiency
- Most fisheries statewide will be affected; some may be reduced to the point that it is not feasible (i.e., drift gill net fishery).
- Some fishermen may need to modify gear/vessel to comply.
- Increases difficulty of enforcement; would require Marine Patrol to physically measure gear

Option 6: Specify that the allowable yardage of gill nets, with stretched mesh less than four inches, shall not exceed 800 yards per vessel in Internal Coastal Waters regardless of the number of individuals involved, except for drift gill nets from May 1 – October 31 shall not exceed 1,500 yards.

+ May help constrain landings of quota managed species (Spanish mackerel and bluefish) and provide for greater fishing opportunities through extended open seasons
+ Provides exclusion for drift gill nets during the portion of the year the Spanish mackerel and bluefish fisheries are active
+/- Reduces the current average level of effort and provides conservation benefits by potentially increasing the frequency that attended gear is fished and thereby increasing the potential for survival of discarded fish
+/- Changes to per-trip cash flows due to reduction of gear fished, potential increase of product quality, reduction of net needed to purchase and maintain, and increase in trip efficiency
- Some fishermen may need to modify gear/vessel to comply.
- Increases difficulty of enforcement; would require Marine Patrol to physically measure gear

Option 7: Specify that the allowable yardage of gill nets with stretched mesh less than four inches shall not exceed 800 yards per vessel in Internal Coastal Waters north of Highway 58 and 500 yards south of Highway 58, regardless of the number of individual involved, except for drift gill nets from May 1 – October 31 shall not exceed 1,500 yards.

+ May help constrain landings of quota managed species (Spanish mackerel and bluefish) and provide for greater fishing opportunities through extended open seasons
+ Provides exclusion for drift gill nets during the portion of the year the Spanish mackerel and bluefish fisheries are active
+ Lesser yardage limit south of Highway 58 better reflects current yardage use in these areas and imparts some reduction in overall yardage fished.

- +/- Reduces the current average level of effort and provides conservation benefits by potentially increasing the frequency that attended gear is fished and thereby increasing the potential for survival of discarded fish
- +/- Changes to per-trip cash flows due to reduction of gear fished, potential increase of product quality, reduction of net needed to purchase and maintain, and increase in trip efficiency
- \- Some fishermen may need to modify gear/vessel to comply
- \- Increases difficulty of enforcement; would require Marine Patrol to physically measure gear

Option 8: Specify that the allowable yardage of gill nets, with stretched mesh less than four inches, shall not exceed 800 yards per vessel in Internal Coastal Waters regardless of the number of individuals involved. The DMF director may by proclamation allow up to 1,500 yards of drift gill net and specify the area and time it may be fished.

- \+ May help constrain landings of quota managed species (Spanish mackerel and bluefish) and provide for greater fishing opportunities through extended open seasons
- \+ Allows for flexibility to accommodate fisheries where a high volume of gear during certain times and/or areas could be utilized with low incidence of discards
- +/- Can reduce the current average level of effort and provide conservation benefits by potentially increasing the frequency that attended gear is fished and thereby increasing the potential for survival of discarded fish
- +/- Changes to per-trip cash flows due to reduction of gear fished, potential increase of product quality, reduction of net needed to purchase and maintain, and increase in trip efficiency
- \- Some fishermen may need to modify gear/vessel to comply.
- \- Increases difficulty of enforcement; would require Marine Patrol to physically measure gear

Option 9: Specify that the allowable yardage of gill nets with stretched mesh less than four inches shall not exceed 800 yards per vessel in Internal Coastal Waters north of Highway 58 and 500 yards south of Highway 58, regardless of the number of individuals involved. The DMF director may by proclamation allow up to 1,500 yards of drift gill net and specify the area and time it may be fished.

- \+ May help constrain landings of quota managed species (Spanish mackerel and bluefish) and provide for greater fishing opportunities through extended open seasons
- \+ Allows for flexibility to accommodate fisheries where a high volume of gear during certain times and/or areas could be utilized with low incidence of discards
- \+ Lesser yardage limit south of Highway 58 better reflects current yardage use in these areas and imparts some reduction in overall yardage fished.
- +/- Can reduce the current average level of effort and provide conservation benefits by potentially increasing the frequency that attended gear is fished and thereby increasing the potential for survival of discarded fish
- +/- Changes to per-trip cash flows due to reduction of gear fished, potential increase of product quality, reduction of net needed to purchase and maintain, and increase in trip efficiency
- \- Some fishermen may need to modify gear/vessel to comply.
- \- Increases difficulty of enforcement; would require Marine Patrol to physically measure gear

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Attendance requirements

Options for amending attendance requirements presented below are were developed for areas south of Albemarle Sound. Attendance requirements in Albemarle sound and its tributaries are applicable to various ranges of mesh sizes and do not have distance from shore qualifiers. These restrictions were developed over countless years of FMP development and management responses to regional issues and differ drastically than regulations in the rest of the state.

Option 1: *status quo* – attendance requirements under current rule:

- "Attended" is currently defined in Rule 15A NCAC 03I .0101 as being in a vessel, in the water, or on the shore, and immediately available to work the gear and be within 100 yards of any gear in use by that person at all times. Attended does not include being in a building or structure.
- Within 100 feet of the Intercostal Waterway from start of Alligator River canal to South Carolina line
- For gill nets with a stretched mesh less than five inches and within 200 yards of shore, in any areas designated in Rule 15A NCAC 03R .0112(a)
- For gill nets with a stretched mesh less than five inches and within 200 yards of shore, from May 1 to November 30 in any areas designated in Rule 15A NCAC 03R .0112(b) including primary nursery areas, permanent secondary nursery areas, and no trawl areas

Attendance requirements currently in proclamation:

- Deer and School House creeks in Bogue Sound
- Newport River and its tributaries from 7:00 am to 7:00 pm
- Year round within 200 yards of shore in Bay and Pungo rivers and lower portions of the Pamlico and Neuse rivers

+	No rule change required
+	DMF director has proclamation authority under current rules to modify
+	Fishermen are familiar with current attendance requirements
+	No additional regulation for Marine Patrol to enforce
+	Addresses concerns raised with conflict in some areas of the state
-	Attendance requirements are not consistent statewide, which can cause difficulty of enforcement

Option 2: Codify restrictions currently in proclamation into rule.

+	Reduces regulatory complexity by having all current attendance requirements in rule
+/-	Limits the discretionary ability of the DMF director to modify requirements via proclamation
+/-	Rule changes take time, which can delay changes to management strategy.
-	Could add complexity to implementing FMPs in a timely manner

Option 3: Require year-round statewide attendance within 200 yards of shore and/or within designated areas currently in rule, whichever is more restrictive.

+	Reduces regulatory complexity by having consistent attendance requirements statewide
+	Potentially reduces incidence of dead discards by reducing soak times and requiring active fishing of gear
+/-	Limits the discretionary ability of the DMF director to modify requirements via proclamation
-	Concerns with safety at sea if fishermen are required to attend gear
-	Potential decline in efficiency of trips
-	Rule changes take time, which can delay changes to management strategy.
-	Could add complexity to implementing FMPs in a timely manner

Option 4: Require year-round statewide attendance for gill nets with mesh size less than four inches.

+	Reduces regulatory complexity by having consistent attendance requirements statewide

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- + Potentially reduces incidence of dead discards by reducing soak times and requiring active fishing of gear
- + Ease of enforcement compared to current requirements
- +/- Limits the discretionary ability of the DMF director to modify requirements via proclamation
- - Concerns with safety at sea if fishermen are required to attend gear in open waters
- - Concerns with safety of Marine Patrol in open waters
- - Potential decline in efficiency of trips
- - Rule changes take time, which can delay changes to management strategy.
- - Could add complexity to implementing FMPs in a timely manner

Option 5: Require year-round attendance within 200 yards of shore in all areas currently designated in Rule 15A NCAC 03R .0112.

- + Reduces regulatory complexity by removing seasonal requirements (May 1 to November 30 in areas designated in Rule 15A NCAC 03R .0112(b)) creating consistency with other year-round attendance requirements
- + Potentially reduces incidence of dead discards by reducing soak times and requiring active fishing of gear
- +/- Limits the discretionary ability of the DMF director to modify requirements via proclamation
- - Concerns with safety at sea if fishermen are required to attend gear
- - Potential decline in efficiency of trips
- - Rule changes take time, which can delay changes to management strategy.
- - Could add complexity to implementing FMPs in a timely manner

Option 6: Require year-round attendance in all areas currently designated in Rule 15A NCAC 03R .0112.

- + Reduces regulatory complexity by removing seasonal requirements (May 1 to November 30 in areas designated in Rule 15A NCAC 03R .0112(b)) creating consistency with other year-round attendance requirements
- + Potentially reduces incidence of dead discards by reducing soak times and requiring active fishing of gear
- +/- Limits the discretionary ability of the DMF director to modify requirements via proclamation
- - Concerns with safety at sea if fishermen are required to attend gear, especially in large open water areas
- - Potential decline in efficiency of trips
- - Rule changes take time, which can delay changes to management strategy.
- - Could add complexity to implementing FMPs in a timely manner

Option 7: Require year-round attendance in all creeks and/or water bodies less than 200 yards wide. (Most areas that would be affected by this option already have a 200 yard requirement or are included in Rule 15A NCAC 03R .0112 an have seasonal attendance requirements. A year round 200 yards from shore attendance requirement would cover these areas.)

- + Potentially reduces conflict in confined areas that multiple user groups occupy
- + Reduces regulatory complexity by removing seasonal requirements (May 1 to November 30 in areas designated in Rule 15A NCAC 03R .0112(b)) creating consistency with other year-round attendance requirements
- + Potentially reduces incidence of dead discards by reducing soak times and requiring active fishing of gear
- +/- Limits the discretionary ability of the DMF director to modify requirements via proclamation
- - Potential decline in effort and profitability of trips
- - Rule changes take time, which can delay changes to management strategy.
- - Could add complexity to implementing FMPs in a timely manner

Option 8: Modify distance requirement in the definition of ”attend” to allow person and/or vessel being occupied to be within 500 yards of gear being fished.

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- \+ An increase in the distance requirement will allow fishermen to set and attend multiple shots of shorter nets within a larger area as opposed to setting fewer, larger sets.
- \+ The ability to fish shorter shots of net over a larger area actively has the potential to increase efficiency of the gear and operation while simultaneously mitigating the incidence of dead discards.
- \- Increases the effort needed for enforcement by expanding the allowable area an operation can fish
- \- Can create scenarios where an operation would not be able to physically observe their nets for protected species interactions but still be considered "attended", i.e., nets out of view around a marsh edge

Option 9: Modify distance requirement in the definition of "attend" to allow person and/or vessel being occupied to be within 500 yards of gear being fished south of Highway 58.

- \+ An increase in the distance requirement will allow fishermen to set and attend multiple shots of shorter nets within a larger area as opposed to setting fewer, larger sets.
- \+ The ability to fish shorter shots of net over a larger area actively has the potential to increase efficiency of the gear and operation while simultaneously mitigating the incidence of dead discards.
- \+ Increasing the attendance distance south of Highway 58 will allow operations in this area to more efficiently fish their gear within the narrow confines of the fishable habitat.
- \- Increases the effort needed for enforcement by expanding the allowable area an operation can fish
- \- Can create scenarios where an operation would not be able to physically observe their nets for protected species interactions but still be considered "attended", i.e., nets out of view around a marsh edge

Option 10: Remove distance requirement from the definition of "attend" to require a person to be physically in contact with the gear at all times.

- \+ Will ensure that nets are attended and actively fished, potentially reducing to the maximum extent practicable the incidence of dead discards
- \- Fishermen would be limited to one net and therefore efficiency of trips may be reduced.
- \- Profitability of some trips may be reduced to the point that some fisheries may no longer be Feasible.

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Set time and area restrictions

Option 1: *status quo* – prohibition on setting gill nets in current rule:

- Within 150 or 300 yards of bridge crossings in numerous river systems statewide
- Use of gill nets within various set distances from pound nets
- Numerous small embayments, basins, and areas described in Rule 15A NCAC 03J .0402
- In joint fishing waters of Lake Mattamuskeet and within 800 feet of Lock No. 1 on the Cape Fear River
- Adjacent to marked fishing piers

Prohibition on setting gill nets in current proclamations:

- Joint coastal fishing waters from midnight on Friday to midnight on Sunday except for portions of Albemarle and Currituck Sounds

+ No rule change required
+ DMF director has proclamation authority under current rules to modify
+ Fishermen are familiar with current set time and area restrictions.
+ No additional regulation for Marine Patrol to enforce
- Does not address concerns raised with conflict in areas not covered under current rule or proclamation

Option 2: Codify restrictions currently in proclamation into rule.

+ Reduces regulatory complexity by having all restrictions in rule
+/- Limits the discretionary ability of the DMF director to modify restrictions via proclamation
- Rule changes take time, which can delay changes to management strategy.
- Could add complexity to implementing FMPs in a timely manner

Option 3: Specify that nets may be set no sooner than one hour before sunset and retrieved no later than one hour after sunrise statewide.

+ Potentially reduces conflict between user groups
+ Potentially reduces incidence of dead discards by reducing soak times
+ May help constrain landings of quota managed species (Spanish mackerel and bluefish) and provide for greater fishing opportunities through extended open seasons
- Reduces the time that gear is in the water

Option 4: Specify that nets may be set no sooner than one hour before sunset and retrieved no later than noon the following day statewide.

+ Potentially reduces conflict between user groups
+ Potentially reduces incidence of dead discards by reducing soak times
+ May help constrain landings of quota managed species (Spanish mackerel and bluefish) and provide for greater fishing opportunities through extended open seasons
+ Promotes safety at seas by allowing additional time during daylight hours to retrieve gear
- Expected reductions in conflict may be diminished due to increased soak time during daylight hours.

Option 5: Specify that nets may not be fished from midnight on Friday to midnight on Sunday statewide.

+ Reduces the potential for user conflict by removing nets from the water during times when recreational and pleasure boat activity is presumed to be high
+ Enforcement staff can more easily identify and enforce net violations.
- Potential loss in revenue from decline in effort
- Disruption in supply of harvest to local markets

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Option 6: Specify that nets may be set no sooner than one hour before sunset and retrieved no later than one hour after sunrise in areas or Management Units determined by the MFC.

+ Potentially reduces conflict between user groups
+ Potentially reduces incidence of dead discards by reducing soak times
+ May help constrain landings of quota managed species (Spanish mackerel and bluefish) and provide for greater fishing opportunities through extended open seasons
+ Limits setting time requirements to areas where conflict occurs
- Creates inconsistent restrictions across areas that may prove troublesome for enforcement
- Reduces the time that gear is in the water

Option 7: Specify that nets may be set no sooner than one hour before sunset and retrieved no later than noon the following day in areas or Management Units determined by the MFC.

+ Potentially reduces conflict between user groups
+ Potentially reduces incidence of dead discards by reducing soak times
+ May help constrain landings of quota managed species (Spanish mackerel and bluefish) and provide for greater fishing opportunities through extended open seasons
+ Limits setting time requirements to areas where conflict occurs
+ Promotes safety at seas by allowing additional time during daylight hours to retrieve gear
- Creates inconsistent restrictions across areas that may prove troublesome for enforcement
- Expected reductions in conflict may be diminished due to increased soak time during daylight hours.

Option 8: Specify that nets may not be set within 200 feet of docks and improved shorelines. Allow exemption for personal docks and docks where the fishing operation has written permission to fish within 200 feet of dock and/or improved shoreline.

+ Potentially reduces conflict between net fishermen and property owners by removing the gear from areas that could pose conflict
- Removes access for net fishermen from public trust waters
- Need to define docks and improved shorelines for effective enforcement
- Reductions in conflict around docks and improved shorelines may be offset by concentrated effort in other areas.

Option 9: Prohibit use of small mesh nets in areas of high conflict determined by the MFC.

+ Temporarily or permanently reduces conflict in restricted areas
+ Abundance of some marine species may increase in these areas if loss of harvest is not completely recouped by other participants and gears.
+/- Limits the discretionary ability of the DMF director to modify restrictions via proclamation
- Potentially reduces profitability of gill net trips around restricted areas
- Could add complexity to implementing FMPs

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Mesh size limits

Option 1: *status quo* – current rule prohibits use of gill nets with mesh size less than 2.5 ISM

- \+ No rule change required
- \+ DMF director has proclamation authority under current rules to modify mesh size. restrictions, if needed
- \+ No need for fishermen to modify current gear
- \+ No additional regulation for Marine Patrol to enforce
- \- Two and one-half inches may select for sub-legal sizes in some fisheries and promote excessive discards. However, the incidence of sub-legal/unmarketable catch is low and variable across species so impacts from mesh size are difficult to quantify and may be negligible.

Option 2: Increase the minimum mesh size to 2.625 inch ISM

- \+ Potentially reduces incidence of regulatory discards in some fisheries by modifying selectivity of gill nets
- \+ Few trips utilize mesh sizes less than three inches.
- \- Catches of some marketable species may decline due to changes in gill net selectivity; i.e., kingfishes, spot, and Atlantic croaker.
- \- Some fishermen may need to modify gear/vessel to comply.

Option 3: Increase the minimum mesh size to 2.75 inch ISM

- \+ Potentially reduces incidence of regulatory discards in some fisheries by modifying selectivity of gill nets
- \+ Few trips utilize mesh sizes less than three inches.
- \- Catches of some marketable species may decline due to changes in gill net selectivity; i.e., kingfishes, spot, and Atlantic croaker.
- \- Some fishermen may need to modify gear/vessel to comply.

Option 4: Increase the minimum mesh size to 3.0 inch ISM

- \+ Potentially reduces incidence of regulatory discards in some fisheries by modifying selectivity of gill nets
- \+ Few trips utilize mesh sizes less than three inches.
- \- Catches of some marketable species may decline due to changes in gill net selectivity; i.e., kingfishes, spot, and Atlantic croaker.
- \- Some fishermen may need to modify gear/vessel to comply.

VII. SUMMARY FINDINGS AND RECOMENDATIONS

The above information summarizes the available data on the small mesh gill net fishery in North Carolina and provides an initial commentary on actions that the MFC may consider during deliberations of potential changes to the management of small mesh gill nets. The DMF's Gill Net Work Group requests that the MFC provide substantive feedback on the identified issues and potential management actions for further development and refinement. The Work Group acknowledges that the list of issues identified is not exhaustive and that other issues may arise through discussion by the MFC. Issues and actions are presented as potential rule changes but the MFC can elect to pursue implementation of preferred actions through proclamation or some combination with rule changes. It may be prudent to consider directing the implementation of some actions through the DMF director's proclamation authority while rule changes are developed to provide an opportunity to inform the effectiveness of the changes to the management strategy. Additionally, commercial fishermen with knowledge of the small mesh gill net fishery provided valuable input on the feasibility and practicality of some of the actions proposed in this document. However, public comment on the proposed actions has not been formally requested and the MFC may consider soliciting input from its advisory committees to aid in the MFC's deliberations.

VIII. REFEREENCES CITED

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Nov. 3, 2020

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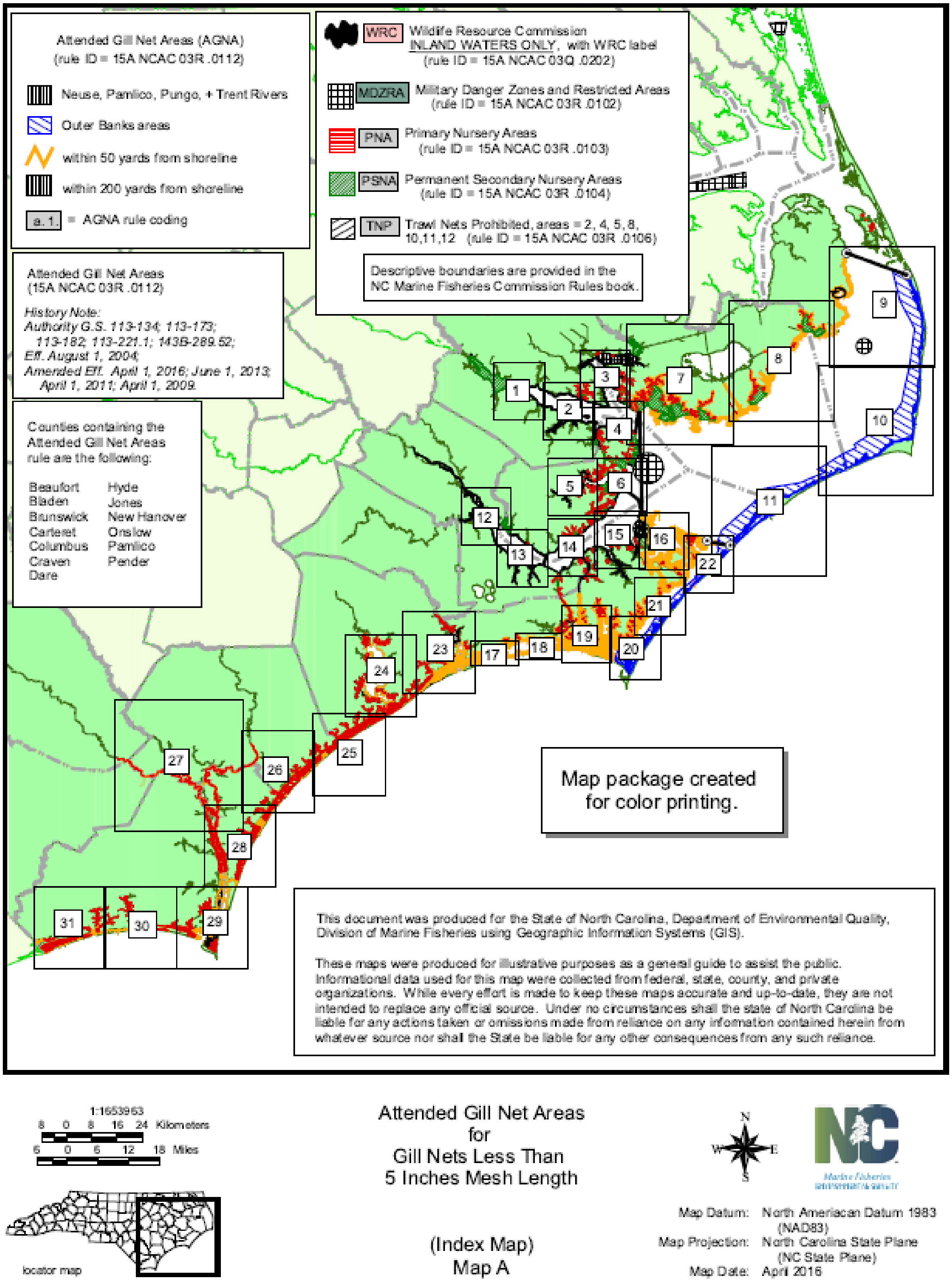

Figure A1. Map of attended areas for small mesh gill nets (<5 inch ISM) http://portal.ncdenr.org/web/mf/attended-gill-net-areas

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GEAR RESTRICTIONS AS A MANAGEMENT TOOL FOR ARTIFICIAL REEFS IN STATE OCEAN WATERS

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ROY COOPER
Governor

MICHAEL S. REGAN
Secretary

STEPHEN W. MURPHEY
Director

November 3, 2020

MEMORANDUM

TO: N.C. Marine Fisheries Commission

FROM: Jason Peters, Enhancement Program Supervisor, Habitat and Enhancement
Jacob Boyd, Section Chief, Habitat and Enhancement

SUBJECT: Gear Restrictions as a Management Tool for Artificial Reefs in State Ocean Waters

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Issue

During it's August 2020 business meeting the Marine Fisheries Commission (MFC) passed a motion asking the Division of Marine Fisheries (DMF) to study making North Carolina's artificial reefs in nearshore ocean waters Special Management Zones (SMZs) bringing recommendations back to the MFC at its November 2020 meeting. An information paper is included in the briefing materials and provides an overview of the recent actions taken by the SAMFC including the use of gear restrictions as a management tool for artificial reefs, and a discussion of how the MFC might take similar actions on nearshore ocean artificial reefs.

Action Needed

The division requests the MFC review options provided in the information paper and provide guidance on how to proceed. If rulemaking action is taken, the MFC should provide guidance on: 1) the scope of the management options to be developed, 2) the potential timeline, and 3) the prioritization of any actions taken.

Findings

While the SMZs pursued in the action taken at the SAFMC were specific to the Snapper-Grouper Fishery Management Plan (FMP), the MFC may consider broader action by utilizing similar gear restrictions but with benefits to all species that utilize artificial reef habitat. The DMF manages 43 ocean artificial reef sites located between 0.5 – 38 nautical miles (nm) off the coast of North Carolina in the Atlantic Ocean. The majority of these artificial reef sites (30) are located in the federally managed Exclusive Economic Zone (EEZ; 3-200 nm) and the remaining artificial reefs sites (13) are located in nearshore state managed ocean waters (0-3 nm). The following is a synopsis of information on using gear restrictions as a management tool for artificial reefs in North Carolina including information on: recent federal action to restrict highly efficient fishing gears at artificial reef sites in the EEZ and recommendations on how the MFC could proceed with similar actions at nearshore artificial reefs sites:

State of North Carolina | Division of Marine Fisheries
3441 Arendell Street | P.O. Box 769 | Morehead City, North Carolina 28557
252-726-7021

- The historical purpose of artificial reefs is to create habitat for fish that is publicly accessible for fishing and diving opportunities.
- Implementation of gear restrictions is an effective management tool for artificial reefs.
- Restricting the use of highly efficient fishing gears on artificial reefs can decrease overexploitation of the reefs and increase protection of protected species.
- The 2016-2019 results from the Access Point Angler Intercept Survey (APAIS) show that trips made with private vessels to artificial reefs make up approximately 12-15% of all private vessel ocean trips in North Carolina.
- North Carolina is awaiting final approval of its request to the SAFMC to add the 30 artificial reefs in the EEZ off the coast of North Carolina to the SAFMC Snapper Grouper FMP as SMZs with gear restrictions.
- If approved, these 30 SMZs will restrict the use of all gears except hand line, rod and reel, and spearfishing to harvest snapper-grouper species and hold spearfishing harvest to the recreational limits.
- While the MFC's current artificial reef rule grants proclamation authority to implement gear restrictions for North Carolina's 13 nearshore artificial reefs, those restrictions are subject to conditions that cannot be met because the rule is obsolete.

<u>Options for consideration by the MFC include</u>**:**

- Remain under status quo:
    - This option does not require any rulemaking but as a result, neither the MFC nor the DMF Director will have the ability to implement gear restrictions for nearshore artificial reefs.
- Implement gear restrictions for nearshore artificial reefs through its rulemaking process that are:
    - Similar to the SAFMC SMZ gear restrictions, which would offer protection to snapper-grouper species, but not state species or other interjurisdictional species.
    - Different from the SAMFC SMZ gear restrictions, which would offer protection to additional species, including state-managed species, but there could be enforcement challenges from having different regulations than those on EEZ artificial reefs.
    - On an individual state FMP basis, just as the SAFMC implemented gear restrictions for a particular FMP (snapper-grouper).
- The MFC could also wait until the final decision by the Department of Commerce Secretary on the North Carolina SMZ request before deciding how to proceed.

For more information please refer to the full document included in this Briefing Book.

GEAR RESTRICTIONS AS MANAGEMANT TOOL FOR ARTIFICIAL REEFS IN STATE WATERS INFORMATION PAPER

Oct. 28, 2020

I. ISSUE

Study subject matter that supports gear restrictions as a management tool for artificial reefs including information on actions recently initiated by the South Atlantic Fishery Management Council (SAFMC). The recent actions taken by the SAFMC were to restrict gear that have the potential to over exploit the resource at these sites and affect access to other users. Since the purpose of artificial reefs is to create habitat for fish that is publicly accessible for fishing and diving opportunities, pursuing similar action for artificial reefs in North Carolina's state ocean waters is likely beneficial. While the actions by the SAFMC provide an example for how gear restrictions may be used as a management tool, similar action by the Marine Fisheries Commission (MFC) must be considered within the framework of the MFC's authority. In addition, the SAFMC actions are specific to the snapper-grouper species complex, while actions by the MFC will likely impact other state and interjurisdictionally managed species. The information provided here is a review of the SAFMC action and how it relates to artificial reefs in North Carolina's state ocean waters. It also includes recommendations on how to proceed with actions that the MFC could take to modify their management of the state artificial reefs to complement the restrictions if they so choose.

II. ORIGINATION

A presentation titled, "Special Management Zones in State Waters" was delivered during the MFC meeting on Aug. 20, 2020. The presentation included a summary of artificial reefs in North Carolina and the status of the North Carolina Division of Marine Fisheries' (DMF) gear restriction request to the SAFMC. Following the presentation, the MFC passed a motion asking the DMF to study making North Carolina's artificial reefs in nearshore ocean waters Special Management Zones (SMZs), possibly limiting the allowable gear, and to bring recommendations back to the MFC at its November 2020 meeting.

III. BACKGROUND

The DMF manages 43 ocean artificial reef sites located between 0.5 – 38 nautical miles (nm) off the coast of North Carolina in the Atlantic Ocean (Figure 1). The majority of these artificial reef sites (30) are located in the federally managed Exclusive Economic Zone (EEZ; 3-200 nm) and the remaining artificial reefs sites (13) are located in nearshore state managed ocean waters (0-3nm; Figure 1).

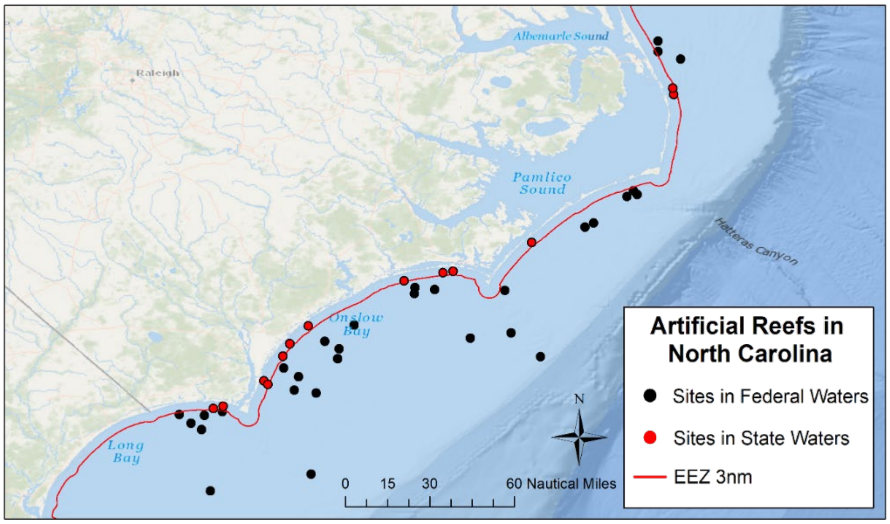

Figure 1: North Carolina ocean artificial reefs separated by state (13 sites; 0-3 nm) and federally (30 sites; 3-200 nm) managed waters.

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Federal fisheries executed off the North Carolina coast in the EEZ are managed under the authority of the Magnuson-Stevens Fishery Conservation and Management Act (MSA; 16 U.S.C. § 1801 et. seq.). The responsibility for decision making for many of these fisheries is delegated from the United States Secretary of Commerce to the SAFMC, with the final decisions made by the Secretary. The MSA, along with creating regional councils to manage federal fisheries, authorized the creation of SMZs. These SMZs are designated marine areas in the EEZ where specific restrictions can be implemented through an existing Fishery Management Plan (FMP). As of October 2020, SMZs are currently designated off the coasts of Florida, Georgia, and South Carolina (SAFMC 2020). Delaware and New Jersey, who are member states of the Mid-Atlantic Fishery Management Council, also have artificial reef sites designated as SMZs that were requested under the black sea bass provisions of the Summer Flounder, Scup, and Black Sea Bass FMP (50 CFR Part 646, 50 CFR Part 648). The first sites to attain SMZ designation were artificial reefs off of South Carolina's coast which, through amendments to the Snapper Grouper FMP, have restricted snapper grouper fishing to handheld gear and recreational limits since the 1980s. The goals of these restrictions were to avoid depletion of the species on artificial reefs, promote equitable fishing on the artificial reef sites, and reduce derelict gear.

As part of the framework provided by the SAFMC Snapper Grouper FMP for designating artificial reefs as SMZs, states may request restrictions on specific fishing gear used to fish for snapper grouper species. Therefore, not all states and subsequent SMZs have the same gear restrictions. The FMP expresses that highly efficient fishing gears, or gears that offer "exceptional advantages," reduce or eliminate the incentive of users with other fishing gears to fish on or promote artificial reefs (SAFMC 1983). Highly efficient fishing gears offer these exceptional advantages through increased catch per effort. Therefore, in this context, gears with this characteristic may be considered all those other than hand line, rod and reel, and spearfishing gear (which includes bang sticks and powerheads).

In March 2019, under the SAFMC framework described above and at the DMF Director's request, the DMF submitted a letter to the SAFMC requesting SMZ designation and gear restrictions at 30 artificial reef sites off of North Carolina's coast in the EEZ. The letter acknowledged the potential for artificial reefs to aggregate fishery resources and requested the SMZ designation with restrictions intended to prevent overexploitation of the resources by use of highly efficient gears. Specifically, DMF requested that fishing gear other than hand line, rod and reel, and spear be prohibited within the proposed SMZs and that harvest of snapper grouper species with spearfishing gear be limited to the appropriate recreational bag limit. The letter also provided the rationale that limitations on highly efficient fishing gears, as proposed, also moderate the potential for disproportionate user access and reduce the potential for negative interactions with protected species listed under the Endangered Species Act (ESA). A similar letter was sent during the same time by South Carolina to designate four additional SMZs, adding to the 29 already existing off of South Carolina's coast.

In June 2019, the SAFMC began development of Regulatory Amendment 34 to the Snapper Grouper FMP. This document details North Carolina's and South Carolina's proposed actions and the potential biological, ecological, economic, social, and fishery management effects of those actions. Public scoping was held in the fall of 2019 and public hearings were held in the spring of 2020, leading to two revisions before final SAFMC approval in June 2020. Following final SAFMC approval, the text was subsequently transmitted to the US Department of Commerce (USDOC) for Secretary of Commerce review in August 2020. If codified into the Code of Federal Regulations (CFR), all 30 ocean artificial reefs off of North Carolina's coast in the EEZ will be designated as SMZs with harvest and gear restrictions. These harvest and gear restrictions will apply only within the boundaries of reef sites and specify that: harvest of snapper-grouper species is only allowed by hand line, rod and reel, and spearfishing gear with spearfishing gear being limited to the applicable recreational bag and possession limits (SAFMC 2020). If given final Secretarial approval, the SMZ designation and the associated harvest and gear restrictions would only apply to the snapper-grouper fishery within the boundary of the 30 ocean artificial reefs in the EEZ off of North Carolina and not to the remaining 13 artificial reef sites located in North Carolina's nearshore ocean waters.

The artificial reef sites located within North Carolina's nearshore ocean waters are managed under the authority of the MFC. Currently, the MFC has one rule specifically pertaining to artificial reefs (15A NCAC 03I .0109). This rule does not contain specific gear restrictions. It delegates authority to the DMF director who may issue a proclamation to prohibit or restrict the taking of fish and the use of equipment in and around artificial reefs, but such a proclamation is dependent on measurements from buoys that no longer exist due to lack of funding and equipment to maintain them. As a result, no special restrictions are presently in place on artificial reef sites in nearshore ocean waters. The rule is subject to readoption per G.S. 150B-21.3A by June 30, 2022 and will be amended as part of that process.

Like those in the EEZ, artificial reefs in North Carolina's nearshore ocean waters are designed as publicly accessible fish aggregation areas, susceptible to overexploitation and potentially having negative interactions with protected species listed under the ESA. The use of gear restrictions as a management tool for artificial reefs in the EEZ could be complemented by MFC implementation of similar gear restrictions for artificial reefs in the nearshore ocean waters through the rulemaking process.

IV. AUTHORITY

<u>North Carolina General Statutes</u>

G.S. § 113-134.	Rules.
G.S. § 113-182.	Regulation of fishing and fisheries.
G.S. § 143B-289.51.	Marine Fisheries Commission – creation; purposes.
G.S. § 143B-289.52. (b) (10)	Marine Fisheries Commission – powers and duties. [artificial reefs]

<u>Marine Fisheries Commission Rules</u>

15A NCAC 03I .0109	Artificial Reefs and Research Sanctuaries

V. DISCUSSION

The SAFMC's proposed designation of artificial reefs as SMZs represents the first gear or harvest restrictions ever placed on ocean artificial reef sites off of North Carolina's coast. This action presents an opportunity for the MFC to consider similar gear restrictions at the 13 artificial reef sites in North Carolina's nearshore ocean waters. The following discussion provides information on the potential effects of restricting highly efficient fishing gears at nearshore artificial reef sites, similar to the information that informed the SAFMC deliberation of Regulatory Amendment 34, and is meant to help inform the MFC in its consideration of taking a similar action.

<u>Highly Efficient Fishing Gears</u>

The purpose of state artificial reef programs is to develop hard bottom habitat that aggregate fishery resources and improves user access to fisheries. Fish aggregating on artificial reefs may be subject to overexploitation, particularly when highly efficient fishing gears are used for harvest. Highly efficient fishing gears are those that offer advantages over other gears through increased catch per effort. Gears with this characteristic may be considered all those other than hand line, rod and reel, and spearfishing gear and can lead to overly exploited artificial reefs. Spearfishing gear is considered efficient but differs from other gears with this characteristic because its efficiency is derived from visually selective harvest of individual fish; catch per unit effort does not differ much from hand line and rod and reel gear.

By restricting the use of highly efficient fishing gears on artificial reefs, the likelihood of overexploitation is reduced. Overly exploited artificial reefs may have negative biological and social effects, including locally reduced user access and disrupted reproductive strategies of certain species that may rely on larger individuals that occur in lower abundance that may be disproportionally exploited by efficient gear or complex social structure that can be disrupted by excessive harvest (SAFMC 2020, Jennings et al. 1998; Jennings et al. 1999; Lloret et al. 2008).

<u>Fisheries and Regulations</u>

As discussed, the mechanism for designating SMZs on artificial reefs in the EEZ is provided in the Snapper Grouper FMP and only applies while fishing for and possessing snapper-grouper complex species. Restrictions on highly efficient fishing gears for artificial reefs in North Carolina's nearshore ocean waters can have a broader application and provide benefits for all state managed species rather than just snapper-grouper complex species. North Carolina's artificial reefs, both in nearshore ocean waters and in the EEZ, are home to a myriad of resident and migratory species. The species abundance, biomass and richness of fish assemblages found on artificial reefs vary according to the type of reef construction and water depth of the site (Paxton et al. 2018). Therefore, the composition of species at artificial reefs in nearshore ocean waters is likely different than that of artificial reefs in

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the EEZ. While sub-tropical species, like those in the snapper-grouper complex, are less likely to be observed at nearshore artificial reefs, a variety of other frequently targeted species such as flounder (*spp.*) are common and subject to overexploitation by highly efficient gears. These nearshore artificial reefs are important habitat for state managed species, including spotted seatrout (*Cynoscion nebulosus*), red drum (*Sciaenops ocellatus*), sheepshead (*Archosargus probatocephalus*), and southern flounder (*Paralichthys lethostigma*). Among recreational fishermen, flounder (*spp.*), red drum, and spotted seatrout are the top three most targeted species, according to a 2018 survey (Table 1; Stemle and Condon 2018). Federally and interjurisdictionally managed species are also found inhabiting North Carolina's nearshore artificial reefs including black seabass (*Cetropristis striata*), summer flounder (*Paralichthys dentatus*), and cobia (*Rachycentron canadum*) to name a few.

Table 1. Species targeted by recreational anglers in North Carolina surveyed with percentages reflecting the proportion of anglers who responded that they target a certain species (Stemle and Condon 2018).

Nearshore Species	% Who Target
Flounder	47
Red drum	40
Spotted Sea Trout	37
Black Drum	29
Weakfish	26
Spot	25
Bluefish	25
Spanish Mackerel	24
Croakers	23
Sea Mullet/Whiting	20
Striped Bass	19
Other	18
Sheepshead	15
Pompano	15
Cobia	13

Many artificial reef sites in the ocean are in relatively close proximity to one another (<10 nm) and as a result, users often visit multiple sites in a single trip, including nearshore and EEZ sites. Gear restrictions at nearshore artificial reef sites applicable to state managed species would be different than those at SMZ-designated artificial reef sites, which could present compliance and enforcement issues. A way to address these issues is to implement gear restrictions for all nearshore artificial reef sites that are identical to the SMZ gear restrictions, but applicable to the artificial reef, not just a single species complex. This would reduce confusion and potentially decrease unintentional non-compliance among users.

Presently, there is insufficient data to determine the frequency of various fishing gear types used on artificial reefs in nearshore ocean waters. Therefore, the economic impacts from potential gear restrictions for these artificial reefs are difficult to quantify. Excluding gear from an area may result in loss of revenue for those participating in related fisheries. However, exclusion of highly efficient fishing gears is intended to maintain abundance of the resource at these areas and may translate to a net positive economic impact over time (SAFMC 2020).

<u>Protected Species</u>

Artificial reefs have also been found to play important roles as habitat and foraging areas for protected species, which are managed by the National Oceanic and Atmospheric Administration (NOAA) Fisheries under the ESA and the Marine Mammal Protection Act (MMPA). There are 29 species of fish, mammals, sea turtles, and corals listed under the Southeast United States ESA region. While not all of these species occur in North Carolina, notable species of fish that do occur include the Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) and scalloped hammerhead (*Sphyrna lewini*). Additionally, populations of several endangered whales, including the highly endangered North Atlantic right whale (*Eubalaena glacialis*), occur in North Carolina waters for a portion of the year (Hayes et al. 2017).

Sea turtles, all of which are protected species under the ESA, are known visitors to artificial reefs and utilize them for shelter and foraging in the same way they utilize natural reefs (Barnette 2017). Artificial reef sites can pose risks of entanglement with fishing line, entrapment inside material or vessels that can lead to drownings, and if in close proximity to newly hatched sea turtle's shoreline sites, may lead to increased predation on the turtles once they enter the water (Barnette 2017). Fishing gear restrictions can reduce the likelihood of gear entanglement and therefore may provide a benefit to sea turtles relative to the current baseline (SAFMC 2020).

Recently, NOAA Protected Resources Division's (PRD) performed an ESA Section 7 programmatic consultation and rendered a biological opinion regarding the effects of North Carolina artificial reefs on protected species. In their biological opinion, NOAA PRD recommended that the DMF Artificial Reef Program take all measures possible to reduce derelict fishing gear on artificial reef material. This directive is intended to prevent entanglement and death of protected species, especially sea turtles that are exposed and may be vulnerable to fisheries gear including trawls, gillnets, purse seines, longlines, bandit gear, hand lines, pound nets, and traps (NOAA PRD 2019). Like those proposed for SMZs, highly efficient fishing gear restrictions at nearshore artificial reefs may be necessary to ensure permitting for future artificial reef enhancement in North Carolina.

Economic effects

While empirical data on fishing activity at artificial reefs are limited, the Marine Recreational Information Program (MRIP) and observational data suggests the artificial reefs in nearshore ocean waters do experience fishing effort. The MRIP seeks to survey recreational fishing effort and estimate catch on the state's resources, including fishing effort on artificial reefs. The MRIP uses an array of sampling techniques including mail and telephone surveys, vessel logbooks, and the Access Point Angler Intercept Survey (APAIS). Field technicians interview fishermen at fishing access points (e.g. piers, boat ramps) and obtain information from the fisherman such as demographics, where they fished, and what they caught. Notably, one of the questions asks whether the fisherman fished on an artificial reef. The 2016-2019 results from the APAIS show that trips made with private vessels to artificial reefs make up approximately 12-15% of all private vessel ocean trips (Table 2). The MRIP surveys do not gather specific information on which artificial reefs were visited, however on average, a greater proportion of trips were made to artificial reefs in nearshore waters than in the EEZ. This is noteworthy because there are considerably fewer artificial reef options in nearshore ocean waters, suggesting individual nearshore reefs may be visited more frequently and therefore receive more fishing effort than individual artificial reef sites in the EEZ.

Table 2. Access Point Angler Intercept Survey (APAIS) results from ocean artificial reef trips in private vessels only.

	Percent (%) of Trips to Artificial Reefs		
Year	**<3nm**	**>3nm**	**Total**
2016	8.78	6.29	15.07
2017	5.86	8.34	14.19
2018*	UNKNOWN	UNKNOWN	UNKNOWN
2019	7.06	5.74	12.80

*Data from 2018 are not known due to a categorization error from the artificial reef survey question.

Currently, there are not enough data to accurately quantify the economic value of artificial reefs (SAFMC 2020). Estimating economic impacts of gear restrictions at these locations is also difficult to quantify due to limited data on artificial reefs including: use, gear use, harvest, and other direct or indirect expenditures. However, restricting allowable gears on artificial reefs is likely to have a direct impact on fisheries which rely on those gears, through loss of revenue. The 13 artificial reefs in nearshore ocean waters have a cumulative area of approximately 3.45 nm^2 (Table 3). Given the relative size of these sites, maximum revenue losses may be low, as was forecasted for the snapper grouper fishery in Regulatory Amendment 34 (SAFMC 2020). However, gear restriction as an action to maintain abundance of the resource may offer an offsetting positive economic impact through increased user access and subsequent expenditures.

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Table 3. Size (nautical miles squared) of all 13 nearshore artificial reefs in North Carolina. *Area of Material* is a representation of two-dimensional area of actual reef materials (vessels, bridge rubble, pipe, etc.) within the reef site boundaries. *Total Reef Area* represents the total permitted area of the reef site.

Site	Area Of Material (nm^2)	Total Reef Area (nm^2)
AR-160	0.00169	0.19146
AR-165*	--	0.19146
AR-275	0.00095	0.19146
AR-315	0.00960	0.76584
AR-320	0.00791	0.19146
AR-342	0.00387	0.19146
AR-360	0.00202	0.19146
AR-364	0.00197	0.19146
AR-370	0.00382	0.76584
AR-378	0.00391	0.19146
AR-378B	0.00022	0.19146
AR-425	0.00235	0.19146
AR-430	0.01987	0.19146
Total	0.05819	3.44630

*Area of material at AR-165 has not been calculated due to how recently material has been deployed.

VI. SUMMARY OF FINDINGS

The following is a synopsis of information on using gear restrictions as a management tool for artificial reefs in North Carolina including information on: recent federal action to restrict highly efficient fishing gears at artificial reef sites in the EEZ and recommendations on how the MFC could proceed with similar actions at nearshore artificial reefs sites:

- The DMF maintains 43 artificial reef sites in the Atlantic Ocean (13 nearshore; 30 EEZ).
- The 13 artificial reefs in North Carolina's nearshore ocean waters are under the authority of the MFC.
- The purpose of artificial reefs is to create habitat for fish that is publicly accessible for fishing and diving opportunities.
- Implementation of gear restrictions is an effective management tool for artificial reefs.
- Restricting the use of highly efficient fishing gears on artificial reefs can decrease overexploitation of the reefs and increase protection of protected species.
- The 2016-2019 results from the APAIS show that trips made with private vessels to artificial reefs make up approximately 12-15% of all private vessel ocean trips in North Carolina (Table 2).
- North Carolina is awaiting final approval of its request to the SAFMC to add the 30 artificial reefs in the EEZ off the coast of North Carolina to the SAFMC Snapper Grouper FMP as SMZs with gear restrictions.
- If approved, these 30 SMZs will restrict the use of all gears except hand line, rod and reel, and spearfishing to harvest snapper-grouper species and hold spearfishing harvest to the recreational limits.
- Current MFC rules do not provide a mechanism to implement gear restrictions for North Carolina's 13 nearshore artificial reefs; a rule change is required.
- Options for the MFC include:
    1. Remain under status quo. This option does not require any rulemaking but as a result, neither the MFC nor the DMF Director will have the ability to implement gear restrictions for nearshore artificial reefs.
    2. Implement gear restrictions for nearshore artificial reefs through its rulemaking process that are:
        a. Similar to the SAFMC SMZ gear restrictions, which would offer protection to snapper-grouper species, but not state species or other interjurisdictional species.
        b. Different from the SAMFC SMZ gear restrictions, which would offer protection to additional species, including state-managed species, but there could be enforcement challenges from having different regulations than those on EEZ artificial reefs.

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c. On an individual state FMP basis, just as the SAFMC implemented gear restrictions for a particular FMP (snapper-grouper).

3. The MFC could also wait until the final decision by the Department of Commerce Secretary on the North Carolina SMZ request before deciding how to proceed.

VII. LITERATURE CITED

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Jason Peters, Jason.Peters@ncdenr.gov, 252-726-7021
Oct. 28, 2020

PROHIBITING REPACKING OF FOREIGN CRAB MEAT IN NORTH CAROLINA

REPACKING FOREIGN CRAB MEAT IN NORTH CAROLINA MEMO

REPACKING FOREGN CRAB MEAT IN NORTH CAROLINA ISSUE PAPER

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ROY COOPER
Governor

MICHAEL S. REGAN
Secretary

STEPHEN W. MURPHEY
Director

October 21, 2020

MEMORANDUM

TO: N.C. Marine Fisheries Commission

FROM: Shannon Jenkins, Section Chief
Shawn Nelson, Inspections Program Supervisor
Shellfish Sanitation and Recreational Water Quality Section

SUBJECT: Prohibiting Repacking of Foreign Crab Meat in North Carolina

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Issue

At its May 2020 business meeting, the Marine Fisheries Commission (MFC) directed Division of Marine Fisheries staff to initiate rulemaking "to make it illegal to repack any imported crab meat in North Carolina into another container for resale in the State of North Carolina." This action followed the MFC review of an information paper titled "Information on Repacking of Foreign Crab Meat in North Carolina" that was presented during the same meeting. The information paper covered several topics. These included the negative publicity regarding fraudulent representation of foreign crab meat as "Product of the USA" by firms including one in North Carolina, and the potential economic impact to N.C. crab processors that currently participate in the repacking of foreign crab meat if the practice was prohibited.

Findings

- The language of the MFC motion as passed would prohibit the repacking of foreign crab meat in North Carolina and subsequent sale within the state. After consultation with legal counsel, it was determined that while the MFC does have authority to promulgate rules that would prohibit the repacking of foreign crab meat by DMF permitted facilities, it does not have the authority to prohibit the sale of repacked foreign crab meat.

- The motion as passed by the MFC would allow foreign crab meat that has been repacked in other states to continue to be marketed in North Carolina retail and grocery outlets.

- Option 1 would support the status quo by continuing to allow the repacking of foreign crab meat by N.C. crab processors. While this option would not resolve the issues expressed by the MFC, it is offered as an option since the MFC's authority is not consistent with the MFC motion in its entirety as passed.

- Option 2 would prohibit the repacking of foreign crab meat in North Carolina into another container via proposed rule 03L .0210 (REPACKING OF FOREIGN CRAB MEAT

State of North Carolina | Division of Marine Fisheries
3441 Arendell Street | P.O. Box 769 | Morehead City, North Carolina 28557
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PROHIBITED). While this would not expressly prohibit the sale as stated in the MFC motion due to the lack of authority, it would effectively accomplish the same result by prohibiting the repacking of foreign crab meat within North Carolina and thus these products would not be available for sale.

- Revisions to two existing MFC rules that reference foreign crab meat (18A .0136 and 18A .0173) are proposed if either option is selected. These revisions would ensure consistency with proposed rule 03L .0210 if selected, and would also ensure conformance with current rulemaking standards regardless of option selected.

Action Needed
The Marine Fisheries Commission will vote on their preferred management option.

For more information, please refer to the full document titled "PROHIBITING REPACKING OF FOREIGN CRAB MEAT IN NORTH CAROLINA ISSUE PAPER" that is included the briefing materials.

PROHIBITING REPACKING OF FOREIGN CRAB MEAT IN NORTH CAROLINA
ISSUE PAPER

October 21, 2020

I. ISSUE

By N.C. Marine Fisheries Commission (MFC) Rule, make it unlawful to repack any imported crab meat in North Carolina into another container for sale in the State of North Carolina.

II. ORIGINATION

An information paper titled "Information on Repacking of Foreign Crab Meat in North Carolina" was presented during the N.C. Marine Fisheries Commission meeting on May 14, 2020. After discussion, the Commission voted to initiate the rulemaking process to make it unlawful to repack any imported crab meat in North Carolina into another container for sale in the State of North Carolina.

III. BACKGROUND

Crab Picking Industry in North Carolina

Blue crab (*Callinectes sapidus*) supports the largest and most valuable commercial fishery in North Carolina (NCDMF 2019). An important part of this fishery involves the harvest of hard-shell crabs from N.C. waters to be sold to N.C. Division of Marine Fisheries (DMF) certified and permitted crab processors. In North Carolina, the number of crab processors, otherwise known as "crab picking" facilities, has decreased significantly from as many as 43 in 1990 to 14 in 2020. Potential factors in the reduced numbers include the live crab or "basket" market where dealers in other states pay higher prices for live crabs, the lack of a steady supply of live crabs due to reduced overall landings during some years, and competition from lower cost crab meat imported from overseas or other states (NCDMF 2020).

Crab processors typically cook baskets of live crabs in a steam retort cooker under pressure to eliminate food-borne pathogens such as bacteria, and produce a product that is shelf-stable. After cooking, the whole crabs are air-cooled prior to being stored in refrigeration. Employees then use sanitary techniques to pick the meat of the crab for subsequent packing, typically into individual plastic containers labeled with their particular brand. Although there is no consensus regarding shelf-life, it appears that N.C. crab processors use a range of 10-14 days, if properly stored, with the extremes being as low as 7 days and as high as 21.

The crab processor may also use pasteurization as an alternative or additional process to further extend the shelf-life of the product by months. Pasteurization involves an additional heating and cooling process after the meat is placed in a hermetically sealed container, typically a metal can.

Repacking

Processors that are certified and permitted by DMF as a crustacea repacker can also repack crab meat that has been previously cooked and packed initially. Crab processors who repack usually do so in order to market the product in their own branded containers. Repacking involves transferring crustacea product from the original packed container into the repacker's branded container using sanitary techniques in accordance with N.C. MFC rules (15A NCAC 18A Section .0134-.0191, *Handling: Packing: and Shipping of Crustacea Meat*). Examples of required sanitary techniques include maintaining a safe temperature during repacking in order to limit bacterial growth, and taking precautions such as sanitizing utensils, tables, etc. to limit possible contamination from the packing process. The repacker is required to label the repacked container with their name, address, certification number followed by the letters "RP", and a code indicating the repack date.

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Repacking of Foreign Crab Meat

In addition to repacking domestically sourced crab product, processors can also repack product from foreign sources. Sources include Asia and South America with countries such as Indonesia, Vietnam, China, Mexico, Brazil, and Venezuela. Imports include the meat from two types of "swimming crabs" that are related to blue crab: *Portunidae* (family that includes blue crabs) and *Callinectes* (blue crab genus). Processors who repack meat from foreign sources typically receive pasteurized product in cans and then repack the product directly into their own branded plastic containers. In addition to the labeling requirements for repacked containers described above, containers that are repacked with foreign crab meat are required to be labeled in accordance with Federal labeling requirements as set forth in MFC rules 15A NCAC 18A .0136 (Applicability of Rules) and .0173 (Repacking).

During the "Issues from Commissioners" portion of the Feb. 20, 2020 MFC meeting, Commissioner Doug Cross requested that the Director of the Division of Marine Fisheries (DMF) consider developing an information paper to amend N.C. MFC Rule 15A NCAC 18A .0173 regarding the repacking of foreign crab meat. Commissioner Cross requested the DMF to examine the possibility of making it unlawful to repack or possess foreign crab meat in North Carolina unless it remains in the original container. The Commissioner stated that recent publicity regarding foreign crab meat being fraudulently represented as local blue crab product hurts North Carolina's crab meat reputation. He further stated that in his opinion the only reason for foreign crab meat to be repacked is to defraud the consumer. The request did not apply to value-added products such as crab cakes or use of foreign crab meat for restaurant use.

The information paper titled "Information on Repacking of Foreign Crab Meat in North Carolina" was presented during the next N.C. MFC meeting on May 14, 2020. The paper covered several topics. These included the negative publicity regarding fraudulent representation of foreign crab meat as "Product of the USA" by firms including one in North Carolina, and the potential economic impact to N.C. crab processors that currently participate in the repacking of foreign crab meat if the practice was to be prohibited.

After presentation of the information paper, Commissioner Cross reiterated his view that the repacking of foreign crab meat into a container other than the original is designed to defraud the customer. He also stated that it results in an economic advantage for those firms repacking foreign crab meat compared to those firms that pack domestic crab meat and that it also reduces the price of domestic crab meat. He offered that consumers would be more confident if they know that foreign crab meat cannot be repacked in North Carolina. After further discussion and by unanimous vote, the MFC passed a motion "to make it illegal to repack any imported crab meat in North Carolina into another container for resale in the State of North Carolina through the rulemaking process."

IV. AUTHORITY

N.C. General Statutes
§ 113-134. Rules.
§ 113-182. Regulation of fishing and fisheries
§ 113-221.2. Additional rules to establish sanitation requirements for scallops, shellfish, and crustacea; permits and permit fees authorized
§ 143B-289.52. Marine Fisheries Commission – powers and duties.

N.C. Marine Fisheries Commission Rules (As of April 1, 2020)
15A NCAC 18A .0135 Permits
15A NCAC 18A .0136 Applicability of Rules
15A NCAC 18A .0173 Repacking

V. DISCUSSION

N.C. General Statutes 113-134, 113-182 and 143B-289.52 provide the MFC the authority to regulate and adopt rules regarding the marine and estuarine resources within its jurisdiction. A new MFC rule in Subchapter 03L section .0200 of the MFC rules (Crabs) appears to be the most appropriate location in the N.C. Administrative Code for prohibiting the repacking of foreign crab meat into another container. It is important to note that the rule should clarify that the prohibition of foreign crab meat repacking does not apply to value-added products such as crab cakes, a topic discussed

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during the May 14, 2020 MFC meeting. The processing of seafood to create value-added products is regulated by the North Carolina Department of Agriculture and so does not fall under the rulemaking authority of the MFC.

A rule that would prohibit the repacking of foreign crab meat within the state would affect a portion of the existing crab meat industry in North Carolina. There are currently three crustacea processing facilities in North Carolina that engage in repacking of foreign crab meat out of the 14 total permitted processors in the state. A change as contemplated above could also affect grocery stores and retail outlets in North Carolina statewide that market foreign crab meat that has been repacked within the state into a container other than the original.

It is also important to note that the action by the MFC would allow foreign crab meat that has been repacked in other states to continue to be marketed in North Carolina retail and grocery outlets. This could result in competition issues for the N.C. crab processors that currently participate in this repacking activity. This would not completely resolve the original concern expressed by Commissioner Cross, which was the opinion that foreign crab meat in a container other than the container that it was initially packed in could deceive the customer even if it is labeled with the country of origin.

The language of the MFC motion as passed would prohibit the repacking of foreign crab meat in North Carolina and subsequent sale within the state. Currently, repacked foreign crab meat can be sold by licensed fish dealers that are clearly under the MFC's authority, but it can also be sold by grocers and other similar retail outlets that can fall under the jurisdiction of other entities, such as the Department of Agriculture. As part of the issue paper process, the laws granting authority to the MFC were reviewed. After consultation with legal counsel, it was determined that while the MFC does have authority to promulgate rules that would prohibit the repacking of foreign crab meat by DMF permitted facilities, it does not have the authority to prohibit the sale of repacked foreign crab meat.

As a result of that determination, there are two options presented in this issue paper. The first option ("Option 1") would support the status quo by continuing to allow the repacking of foreign crab meat by N.C. crab processors. While this option would not resolve the issues expressed by the MFC it is offered as an option since the MFC's authority is not consistent with the MFC motion in its entirety as passed.

A second option ("Option 2") presented would prohibit the repacking of foreign crab meat in North Carolina into another container. While this would not expressly prohibit the sale as stated in the MFC motion due to the lack of authority, it would effectively accomplish the same result by prohibiting the repacking of foreign crab meat within North Carolina and thus these products would not be available for sale. The proposed new rule for this option specifies that it applies to those crab processing facilities permitted by DMF in accordance with MFC Rule 15A NCAC 18A .0135 (Permits). The proposed new rule also clarifies that the prohibition of the repacking of foreign crab meat does not apply to crab meat that has been transformed into another product such as crab cakes or other value-added products.

It is important to note that very little precedent or academic research on this proposed rule change exists to help understand how North Carolina's seafood markets might be affected moving forward if Option 2 was selected. While Option 2 would likely provide the intended effects of increased consumer confidence in North Carolina crab products, there is no clear evidence that domestic blue crab prices would be bolstered by the removal of repackaged foreign crab meat in the state. Overall, there is an assertion that the removal of foreign crab meat products that have been repacked in North Carolina would result in higher prices for domestic blue crab product. However, this assertion may not fully account for the presence of repackaged foreign crab meat that was processed in another U.S. state, which the MFC does not have rulemaking authority to regulate. With this, as these out-of-state products are a stronger substitute for repackaged foreign crabmeat in North Carolina, there would likely be no market impacts to domestic blue crab demand in the state, and therefore no price effects would be observed.

In addition to the adoption of a new rule, there are two existing MFC rules that would need to be amended due to references to foreign crab meat if Option 2 was selected. MFC Rule 15A NCAC 18A .0136 (Applicability of Rules) currently requires that "Foreign crustacea meat processed in North Carolina shall comply with all applicable Federal requirements." This provision should be deleted if the repacking of foreign crab meat within North Carolina is prohibited under Option 2, as there does not appear to be any processing of foreign crab meat that could occur other than repacking.

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MFC Rule 15A NCAC 18A .0173 (Repacking) currently requires that “Quarterly bacteriological reports shall be provided to the Division by the repacker of all foreign crustacea meat for repacking.” This provision should also be deleted if the repacking of foreign crab meat is prohibited under Option 2, as N.C. crab processors would no longer be allowed to repack foreign crab meat so the requirement to submit reports would be made moot.

MFC Rule 15A NCAC 18A .0173 also currently requires that “Each container of foreign crustacea meat which has been repacked shall be labeled in accordance with Federal labeling requirements.” With the selection of Option 2, this rule should be further amended to clarify that “foreign crustacea meat which has been repacked outside of North Carolina shall be labeled in accordance with Federal labeling requirements.” This would further clarify that foreign crab meat cannot be repacked in North Carolina if Option 2 is implemented. The amended passage would continue to require that foreign crab meat that has been repacked outside of North Carolina meets Federal labeling requirements while being marketed in North Carolina.

VI. PROPOSED RULE(S)

Option 1: No substantive changes, just conforming updates for grammar, punctuation, and capitalization.

15A NCAC 18A .0136 APPLICABILITY OF RULES

The Rules in this Section shall apply to the operation of all facilities and persons permitted in Rule .0135 of this Section and all other businesses and persons that buy, sell, ~~transport~~ transport, or ship cooked crustacea or crustacea meat ~~which~~ that has not been transformed into another product. Foreign crustacea meat processed in North Carolina shall comply with all applicable Federal requirements.

History Note: Authority G.S. ~~130A-230;~~113-134; 113-182; 113-221.2; 143B-289.52;
Eff. October 1, 1992;
Amended Eff. April 1, 1997;
Readopted Eff. April 1, 2022.

15A NCAC 18A .0173 REPACKING

(a) Crustacea meat for repacking ~~which~~ that is processed in North Carolina shall comply with Rules .0134 through .0187 of this Section. Crustacea meat for repacking ~~which~~ that is processed outside of North Carolina shall comply with Rule .0182 of this Section. Quarterly bacteriological reports shall be provided to the Division by the repacker of all foreign crustacea meat for repacking.

(b) The repacker shall provide the Division of Marine Fisheries a current written list of all sources of crustacea meat used for repacking.

(c) Repacking of crustacea meat:

(1) Crustacea meat shall not exceed 45° F (7.1° C) during the repacking process.

(2) Repacking shall be conducted separately by time or space from the routine crustacea meat picking and packing process.

(3) The food contact surfaces and utensils utilized in the repacking process shall be cleaned and sanitized prior to repacking and thereafter on 30 minute intervals during repacking.

(4) Repacked crustacea meat shall be maintained at or below 40° F (4.4° C).

(5) Blending or combining of any of the following shall be prohibited:

(A) ~~Fresh~~ fresh crustacea meat.
(B) ~~Frozen~~ frozen crustacea meat.
(C) ~~Pasteurized~~ pasteurized crustacea meat.
(D) ~~Crustacea~~ crustacea meat packed in another facility.

(6) Crustacea meat shall not be repacked more than one time.

(7) All empty containers shall be rendered unusable.

(d) Labeling of repacked crustacea meat:

(1) Each container shall be legibly embossed, ~~impressed~~ impressed, or lithographed with the repacker's or the distributor's name and address.

(2) Each container shall be legibly embossed, ~~impressed~~ impressed, or lithographed with the repacker's certification number followed by the letters "RP."

(3) Each container shall be permanently and legibly identified with a code indicating the repack date.

(4) Each container shall be sealed so that tampering can be detected.

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(5) Each container of foreign crustacea meat which has been repacked shall be labeled in accordance with Federal labeling requirements.

(e) Records shall be kept for all purchases of crustacea meat for repacking and sales of repacked meat for one year. The records shall be available for inspection by the Division.

History Note: *Authority G.S. ~~130A-230;~~113-134; 113-182; 113-221.2; 143B-289.52;*
Eff. October 1, 1992;
Amended Eff. August 1, 2002; April 1, 1997;
Readopted Eff. April 1, 2022.

Option 2: Prohibits the repacking of foreign crab into another container within North Carolina.

15A NCAC 03L .0210 REPACKING OF FOREIGN CRAB MEAT PROHIBITED

It shall be unlawful to repack foreign crab meat in North Carolina into another container. This rule shall apply to all facilities and persons permitted in accordance with Rule 15A NCAC 18A .0135. This rule does not apply to crab meat that has been transformed into another product, such as crab cakes or other value-added products.

History Note: *Authority G.S. 113-134; 113-182; 113-221.2; 143B-289.52;*
Eff. April 1, 2022.

15A NCAC 18A .0136 APPLICABILITY OF RULES

The Rules in this Section shall apply to the operation of all facilities and persons permitted in Rule .0135 of this Section and all other businesses and persons that buy, sell, ~~transport~~ transport, or ship cooked crustacea or crustacea meat ~~which~~ that has not been transformed into another product. ~~Foreign crustacea meat processed in North Carolina shall comply with all applicable Federal requirements.~~

History Note: *Authority G.S. ~~130A-230;~~113-134; 113-182; 113-221.2; 143B-289.52;*
Eff. October 1, 1992;
Amended Eff. April 1, 1997;
Readopted Eff. April 1, 2022.

15A NCAC 18A .0173 REPACKING

(a) Crustacea meat for repacking ~~which~~ that is processed in North Carolina shall comply with Rules .0134 through .0187 of this Section. Crustacea meat for repacking ~~which~~ that is processed outside of North Carolina shall comply with Rule .0182 of this Section. ~~Quarterly bacteriological reports shall be provided to the Division by the repacker of all foreign crustacea meat for repacking.~~

(b) The repacker shall provide the Division of Marine Fisheries a current written list of all sources of crustacea meat used for repacking.

(c) Repacking of crustacea meat:

(1) Crustacea meat shall not exceed 45° F (7.1° C) during the repacking process.

(2) Repacking shall be conducted separately by time or space from the routine crustacea meat picking and packing process.

(3) The food contact surfaces and utensils utilized in the repacking process shall be cleaned and sanitized prior to repacking and thereafter on 30 minute intervals during repacking.

(4) Repacked crustacea meat shall be maintained at or below 40° F (4.4° C).

(5) Blending or combining of any of the following shall be prohibited:

(A) ~~Fresh~~ fresh crustacea meat.

(B) ~~Frozen~~ frozen crustacea meat.

(C) ~~Pasteurized~~ pasteurized crustacea meat.

(D) ~~Crustacea~~ crustacea meat packed in another facility.

(6) Crustacea meat shall not be repacked more than one time.

(7) All empty containers shall be rendered unusable.

(d) Labeling of repacked crustacea meat:

(1) Each container shall be legibly embossed, ~~impressed~~ impressed, or lithographed with the repacker's or the distributor's name and address.
(2) Each container shall be legibly embossed, ~~impressed~~ impressed, or lithographed with the repacker's certification number followed by the letters "RP."
(3) Each container shall be permanently and legibly identified with a code indicating the repack date.
(4) Each container shall be sealed so that tampering can be detected.
(5) Each container of foreign crustacea meat which has been repacked outside of North Carolina shall be labeled in accordance with Federal labeling requirements.

(e) Records shall be kept for all purchases of crustacea meat for repacking and sales of repacked meat for one year. The records shall be available for inspection by the Division.

History Note: *Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52;*
Eff. October 1, 1992;
Amended Eff. August 1, 2002; April 1, 1997;
Readopted Eff. April 1, 2022.

VII. PROPOSED MANAGEMENT OPTIONS

1. Status quo: continue to allow the repacking of foreign crab meat by N.C. crab processors.

+ Avoids any economic impact on some N.C. crab processors and a number of grocery stores and retail outlets that market that type of product.
+ / – Does not resolve any economic advantage of N.C. repacked foreign crab meat over domestic crab meat.
– Does not comply with MFC motion.
– Does not resolve the potential for confusion by N.C. consumers regarding whether retail crab meat is domestic or foreign.

2. Adopt MFC Rule 15A NCAC 03L .0210 that would prohibit the repacking of foreign crab meat. Also, amend references to foreign crab meat in MFC Rules 15A NCAC 18A .0136 and .0173 accordingly.

+ Achieves the goal of the MFC motion.
+ Reduces the potential for confusion by N.C. consumers regarding whether retail crab meat is domestic or foreign.
+ / – Alleviates any economic advantage of N.C. repacked foreign crab meat over domestic crab meat.
– Has a negative economic impact for those N.C. crab processors that participate in the repacking of foreign crab meat and any grocery stores or retail outlets that market that type of product.

Prepared by: Shannon Jenkins, shannon.jenkins@ncdenr.gov, 252-808-8148
Shawn Nelson, shawn.nelson@ncdenr.gov, 252-808-8157
June 22, 2020

Revised: August 14, 2020
August 24, 2020
August 25, 2020
September 8, 2020
September 14, 2020
September 30, 2020
October 8, 2020
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2019 LANDINGS OVERVIEW

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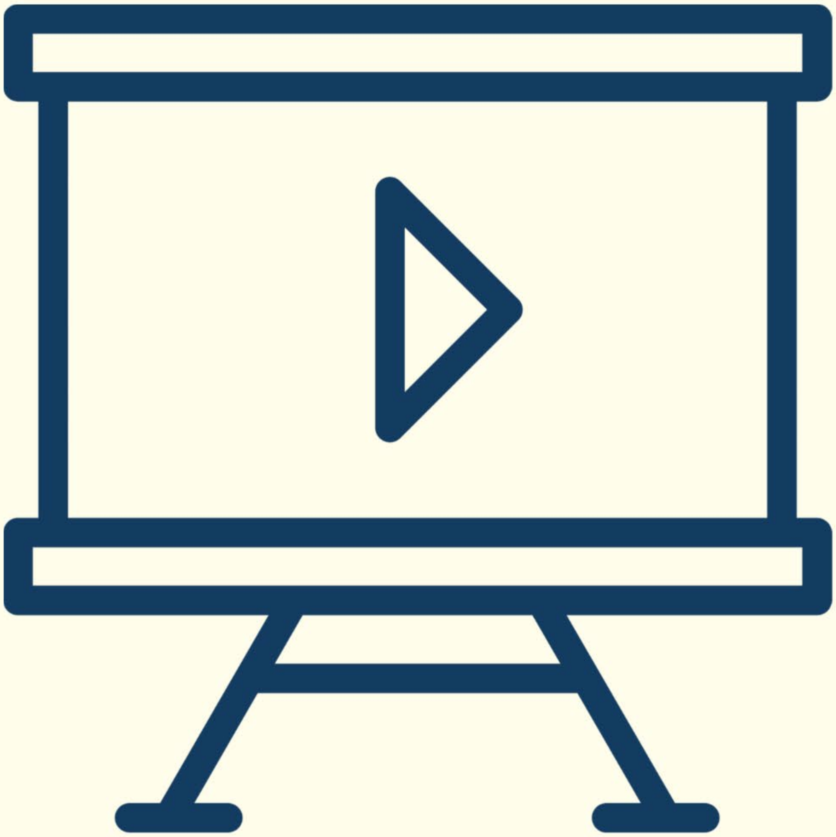

A PowerPoint Presentation Will be Given During the Business Meeting

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COASTAL HABITAT PROTECTION PLAN

COASTAL HABITAT PROTECTION PLAN MEMO

COASTAL HABITAT PROTECTION PLAN
JULY 30 MEETING MINUTES

COASTAL HABITAT PROTECTION PLAN
OCTOBER 16 MEETING MINUTES

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ROY COOPER
Governor
MICHAEL S. REGAN
Secretary

NORTH CAROLINA
Environmental Quality

MEMORANDUM

TO: Marine Fisheries Commission
Coastal Resources Commission
Environmental Management Commission

FROM: Jimmy Johnson, Albemarle-Pamlico National Estuary Partnership
Anne Deaton, Division of Marine Fisheries

DATE: October 30, 2020

SUBJECT: Update on the 2021 Coastal Habitat Protection Plan Amendment

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Issue

Update the Marine Fisheries Commission (MFC), Coastal Resources Commission (CRC), and Environmental Management Commission (EMC) on the status of the ongoing amendment to the 2021 North Carolina Coastal Habitat Protection Plan (CHPP).

Overview

At the MFC 's August 2020 business meeting, and CRC and EMC's September 2020 business meetings, staff provided an update on the 2021 Coastal Habitat Protection Plan Amendment. A timeline for completing the amendment and the five selected priority issues were reviewed. Staff received constructive comments and questions. Since those presentations to the commissions, discussions among the agencies have increased, and led to a re-examination of the amendment timeline. The CHPP Team decided that additional time was needed to adequately incorporate all the information needed and get sufficient review by other agencies and the public. The issue papers focus on complex issues that require coordination with and information from multiple agencies. The timeline was discussed with the division directors, and there was consensus that extending the deadline would be beneficial. Despite the updated timeline, the plan review and amendment will still be completed within the statutorily required five-year timeframe (Table 1).

Since the last commission meeting, work on the remaining issue papers continues. Additionally, three online Wetland Technical Workshops were held in Aug. The purpose of the meetings was to receive input from a broad group of scientists and managers on the current state of our knowledge regarding wetland extent, condition, and threats, and have discussion on needs to advance wetland conservation and restoration. Seventy participants from state and federal agencies, non-government organizations, and academia attended.

A CHPP Steering Committee meeting was held in October. Three presentations were given by habitat and water quality experts to provide a foundation for future discussions regarding management of submerged aquatic vegetation, wetlands, and water quality. Updates on issue paper progress were also provided.

Table 1. Timeline of CHPP milestones relevant to DEQ commission meetings.

Action	Quarter	MFC	CRC	EMC
Provide CHPP background, implementation progress, and process for 2021 amendment	Fall 2019	Nov 15	Nov 20	Nov 14
Provide background on SAV, Compliance, and I&I issue papers	Summer 2020	Aug 20-21	Sep 9	Sep 10
Provide update on timeline	Fall 2020	Nov 19-20	Nov 18-19	Nov 18-19
Present background on Wetlands and Habitat Monitoring issue papers	Winter 2021	Feb 17-19	Feb 17-18	Mar 10-11
Provide update on revision status	Spring 2021	May 19-21	Jun 9-10	May 12-13
Present entire draft amendment; ask to take out for public comment (**action item**)	Summer 2021	Aug 25-27	Sep 15-16	Sep 8-9
Review public comments received; ask for final plan approval (**action item**)	Fall 2021	Nov 17-19	Nov 9-10	Nov 17-18
Present public friendly short plan for outreach purposes	Spring 2022	TBD	TBD	TBD

Action Needed

For informational purposes only, **no action is needed at this time**.

ROY COOPER
Governor
MICHAEL S. REGAN
Secretary

NORTH CAROLINA
Environmental Quality

MEMORANDUM

TO: Coastal Resources Commission
Environmental Management Commission
Marine Fisheries Commission
Coastal Habitat Protection Plan Steering Committee

FROM: Jimmy Johnson
Albemarle-Pamlico National Estuary Partnership
Anne Deaton
Division of Marine Fisheries

DATE: August 3, 2020

SUBJECT: Coastal Habitat Protection Plan Steering Committee Meeting

The Coastal Habitat Protection Plan Steering Committee met via webinar at 9:00 a.m. Thursday, July 30, 2020. The following attended:

Commissioners: Martin Posey, Pete Kornegay, Bob Emory, Larry Baldwin, David Anderson, Yvonne Bailey

DMF Staff: Dan Zapf, Katy West, Anne Deaton, Casey Knight, Alan Bianchi, Corrin Flora, Kimberly Harding, Jimmy Harrison, Jacob Boyd, Jason Rock, Shannon Jenkins
APNEP Staff: Bill Crowell, Jimmy Johnson, Trish Murphey, Tim Ellis
DCM Staff: Braxton Davis, Curt Weychert, Mike Lopazanski, Daniel Govoni
DWR Staff: Adriene Weaver, David May, Forest Shepard, Chris Pullinger
DEMLR Staff: Samir Dumpor
NCDA&CS: Eric Pare (S&W), Alan Coates (Forest Service)
Public: Bill Ross (Brooks-Pierce), Paul Cough (APNEP), Kelly Garvy (The Pew Charitable Trust) Leda Cunningham (The Pew Charitable Trust), Stacy Trackenberg (ECU), Todd Miller (NCCF)

WELCOME, INTRODUCTIONS AND APPROVE AGENDA

Jimmy Johnson, serving as chair, called the meeting to order. He welcomed everyone on the webinar and asked them to provide a name, who they represent and their favorite beach, in the chat box, in order to get a list of attendees. He called the roll for commissioner attendance. All commissioners were present.

North Carolina Department of Environmental Quality | Division of Human Resources
217 West Jones Street | 1601 Mail Service Center | Raleigh, North Carolina 27699-1601
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Motion by Bob Emory to approve the agenda. Seconded by Martin Posey. Motion carries unanimously.

APPROVE MINUTES FROM MAY 11, 2020 MEETING

Motion by Martin Posey to approve the minutes of the May 11, 2020 meeting. Second by Pete Kornegay. Motion carries unanimously.

REVIEW OF ISSUE PAPERS

Jimmy Johnson (APNEP) reviewed the timeline of the 2021 CHPP development along with drafting and reviewing issue papers. Today we will review two issue papers along with recommendations for approval by the CHPP Steering Committee. There will be three more issue papers for review in October by the committee. Approval for the draft 2021 CHPP to go out for public comment by the three commission will likely be in November. The timeline is tight, but the 2021 CHPP should be finalized by the spring/summer of 2021.

SAV and Water Quality Protection and Restoration with Focus on Water Quality Improvements

Casey Knight (DMF) reviewed the issue paper SAV and Water Quality Protection and Restoration with a Focus on Water Quality to the committee. Protection and restoration of submerged aquatic vegetation (SAV) habitat is critical for healthy fisheries in NC while also providing additional valuable ecosystem services and benefits that enhance coastal resiliency for aquatic life and coastal communities. These services include primary and secondary fisheries production, habitat for fish, wildlife, and waterfowl, sediment and shoreline stabilization, wave energy attenuation, water purification, and carbon sequestration. There are two distinct groups of SAV ecosystems in NC distributed according to the estuarine salinity. One group occurs in moderate to high (<10 ppt) salinity estuarine waters of the bays, sounds, and tidal creeks, referred to as high salinity SAV or seagrasses. The other group thrives in fresh to low salinity riverine waters (≥10 ppt), referred to as low salinity SAV or freshwater grasses. Collectively, they are referred to as SAV. These groups are also distinguished by different species composition and living requirements, but the primary factors controlling SAV distribution are water depth, sediment composition, wave energy, and the penetration of light through the water column. North Carolina is unique from other coastal SAV ecosystems on the Atlantic seaboard because of the overlapping distribution of temperate and tropical seagrasses in high salinity waters. Eelgrass (*Zostera marina*) is a temperate species at the southern limit of its western Atlantic range in NC. In contrast, shoal grass (*Halodule wrightii*) is a tropical species that reaches its northernmost extent in NC. Widgeon grass (*Ruppia maritima*) has a wide salinity tolerance, but grows best in moderate salinity areas.

Currently, NC is steward to one of the most productive and biodiverse SAV resources on the Atlantic seaboard, including the largest in-tact high salinity seagrass meadows in the south Atlantic. Over the last 40+ years various mapping projects have been conducted by several universities and state and federal agencies. These individual mapping events have been compiled and overlaid to make up the historically known extent of approximately 191,155 acres of SAV in NC. This is currently the best known estimate of where SAV has persisted in the past, may currently persist, and will hopefully persist in the future. Therefore, the recommended coastwide interim SAV protection and restoration goal is approximately 191,155 acres. The NC coast and the known historic SAV extent is further divided into nine SAV regions to best represent waterbodies and regional variability. These SAV waterbody regions will be beneficial to setting smart and targeted recommendations on how to obtain these acreage goals. Due to the varying methodologies, extents, resolutions, seasonality, and timeframes, etc. of the mapping events compiled to make the known historic extent of SAV in NC, the regions will allow for goals to be set coastwide and by region allowing for targeted recommended actions. The acreage goals will also be able to be informed and refined by region based on the most current and best resolution mapping events as older mapping data is re-evaluated and new mapping data becomes available. To work towards achieving the interim acreage SAV goal for protection and restoration several recommended actions were presented.

Larry Baldwin asked about the value of chlorophyll *a* as a metric and said there is debate on whether it's a good metric. Knight explained that here, chlorophyll *a* is an interim target that will be used to determine nitrogen load in the future.

Martín Posey asked about sedimentation and how it would be incorporated into the models. Knight explained that sediment does have an impact. Subsequent management measures that reduce nutrient loading from runoff will also reduce sediment loading. Staff said they would follow up on that. Anne Deaton (DMF) added that both Chesapeake Bay and Tampa Bay had tremendous success in controlling nutrients as primary strategy.

Bob Emory questioned if you could see declines of SAV in waterbodies that had a current chlorophyll *a* TMDL. Knight explained that at this point, we cannot due to existing mapping information in those areas. That shows the need for having an more robust SAV monitoring program that could demonstrate that connection.

Baldwin asked about the SAV acreage goal and commented that SAV distribution has a lot of natural variability and if the SAV mosaic was a blended inventory of multiple years and how to account for SAV natural variability. Knight explained that the mosaic is an inventory of several mappings that have occurred over time. It indicates where SAV has occurred at some point in time and could again if conditions are suitable. The mapping dates are in the issue paper and current acreage goal is an interim goal based on this mosaic. If water quality conditions are improved, SAV will be able to recover faster (more resilient) following adverse weather conditions.

Knight reviewed the recommendations and explained that there are some missing dates and that some wording may be changed slightly in order to make them SMART but the intent of the recommendations will not change.

Posey asked about recommendation #2 and if we are setting a deep edge goal or is it something we can determine. Trish Murphey (APNEP) explained that the deep edge depths were already determined based on previous work and is 1.5 meters for the low salinity SAVs and 1.7 meters for the high salinity SAVs.

Emory asked about the mechanisms of adopting targets, does it need to go through the EMC? Who adopts the SAV targets? He suggested that the 22% light to a depth of 1.7 meters and 13% to 1.5 meters be included in the recommendations.

Baldwin expressed some concerns about the recommendations and the need to be more concise. He felt they were too wordy and would lose people. He suggested that rule making should be considered and also think about enforcement and legislative actions and that these recommendations need to be as concise and doable as possible. Knight explained that we can change the wording and structure to address his concerns.

Baldwin also suggested mitigation as a funding mechanism for SAV restoration. It has been successful for wetlands and streams and a lot of resource agencies support mitigation. Baldwin also discussed boat prop dredging/sedimentation and the amount of boats that are out on the water. He suggested the idea of establishing boat carrying capacity for water bodies that have public boat ramps.

Motion by Martin Posey to accept the recommended actions with the understanding that potential changes to wording will be made in order to make them more clear and concise, without any change to their intent. Seconded by Pete Kornegay. Motion carries unanimously.

Environmental Rule Compliance to Protect Habitat and Water Quality

Deaton reviewed the issue paper, Environmental Rule Compliance to Protect Habitat and Water Quality. The paper summarized NC compliance inspections and studies that have looked at compliance in NC and elsewhere. Inspections in NC support the conclusions of the studies that greater compliance is achieved when the public knows that inspections are likely to occur. Non-compliance leads to unauthorized wetland loss and water quality degradation, and with increasing habitat loss and degradation, there is a loss of ecosystem services, like flood control, filtering of pollutants, and provision of suitable juvenile fish habitat. Small thresholds of impacts to wetlands and streams are allowed, and although small, are cumulatively significant. In five years (2014-2019), the impacts within the coastal draining river basins was 1,499 acres. In the same time period there were 1.54 acres of unauthorized impacts for every 1.0 acre of authorized/permitted impacts. Having dedicated compliance inspection positions greatly increases compliance and could result in over 50% less impacts to wetlands with no new rules. Deaton noted that public comments have consistently expressed support for enforcement of existing rules and this issue has been a CHPP priority since 2005. Although new compliance positions were created in 2006, severe budget cuts have limited time availability for compliance inspections. The CHPP Steering Committee reviewed recommended actions which included seeking funding for dedicated compliance positions, additional outreach to increase the public's understanding of EMC and CRC rules and how to recognize potential violations, and establishing a public portal on DEQ's website where it is easy to find out about past violations, and to submit complaints about potential violations.

The CHPP Steering Committee discussed the recommended actions. Larry Baldwin noted that enforcement should be a last resort. Two CHPP team members with DWR and DEMLR explained that since the 2000s staff emphasizes outreach to applicants at the front end. Rather than being heavy handed when problems are found, division staff offer assistance to get into compliance. They both noted that increased compliance with regular inspections leads to less enforcement actions being needed.

Motion by Pete Kornegay to approve all of the recommended actions in the compliance issue paper. Seconded by Martin. Motion carries unanimously.

PUBLIC COMMENT
No public comment.

BREAK
Johnson called a break and to return by 11:00am.

OTHER CHPP ISSUE PAPER UPDATES
Deaton provided information to the committee on three additional issue papers that are not yet complete but will be for the next meeting.

Reducing Inflow and Infiltration (I&I) from Wastewater Infrastructure to Improve Water Quality

Deaton presented an update on the upcoming issue paper "Reducing Inflow and Infiltration (I&I) from Wastewater Infrastructure to Improve Water Quality". She explained that I&I is the term used for a common type of wastewater infrastructure problems. Inflow is when stormwater gets into wastewater collection pipes and infiltration is when groundwater gets into the pipes. The increased volume of water entering the pipes is frequently the cause of sanitary sewer overflows. If the raw or partially treated sewage enters surface waters, it can significantly degrade waters for a period of time and result in algal blooms and fish kills. Studies have shown that infiltration is the more significant problem. This issue is widespread in the coastal counties and costly to correct. The coast is particularly vulnerable to I&I problems due to high groundwater table and higher average rainfall than other areas of NC. Climate change is expected to exasperate those factors. The draft issue paper will be presented at the next CHPP Steering Committee Meeting.

Baldwin commented that I&I is definitely a problem and that money is what is needed. In the 301 program, the US Congress appropriated money for infrastructure but did not include maintenance and operational funding. This cost was put on the states. He noted that EMC has done a great job with the Clean Water State Revolving Fund. There has been a lot of improvement in wastewater systems, stricter site selection, etc. Municipalities are seeking funds and loans to upgrade their systems.

Wetland Protection and Restoration with Focus on Nature-Based Methods

Deaton then presented an update on the issue paper "Wetland Protection and Restoration with Focus on Nature-Based Methods". She explained that the paper is in its initial drafting stage. Staff will be holding three virtual technical meetings to broaden input from researchers, other agencies, and NGOs. The first meeting will focus on mapping and monitoring, the second will focus on threats and conservation, and the third will focus on restoration and living shorelines. The information obtained will aid in drafting the issue paper.

Habitat Monitoring to Assess Status and Regulatory Effectiveness

Deaton also provided an update on the issue paper "Habitat Monitoring to Assess Status and Regulatory Effectiveness". The paper will include updated status on each habitat, and summarize monitoring needs for each to improve understanding of their condition and trends over time.

Existing monitoring will be noted, and recommendations that may be included in the SAV or wetlands issue papers will be referenced. This issue paper will provide a blueprint for monitoring the state of our coastal habitats in an efficient and feasible manner.

These papers should be finished by October. Martin asked about thoughts on restoration and Deaton explained that there are techniques to do large scale restoration, thin layer sediment dispersal, island creations/expansion, hydrological restoration. Additionally, protecting wetlands from high wave energy can reduce wetland loss due to erosion. Several examples were discussed including NCCF North River Farms and Poplar Island in Chesapeake Bay.

OUTSIDE PRESENTATIONS TO COMMITTEE

The Pew Charitable Trust: CHPP Outreach Efforts

Kelly Garvy (Pew) introduced herself and explained that she has been contracted by Pew and North Carolina Coastal Federation (NCCF) to develop outreach and education information and would like to discuss with the committee some ideas and get feedback. Leda Cunningham (Pew) provided a brief introduction and overview of Pew and that one of its priorities is coastal habitats and focusing on policy vehicles like the CHPP. She emphasized the need to build partnerships and gave the example of the March SAV/Water Quality Workshop. Garvey explained that people do not understand the connection of CHPP's role in maintaining these coastal habitat systems. Pew can provide an additional set of hands to get the word out to the public; what the CHPP is and what is its connection to other state efforts. Discussion continued on what the public needs to know and how to engage the public about the CHPP. Garvey provided three questions for discussion: 1) What do you think the public should know about the CHPP? 2) What are your thoughts and feedback on our approach? 3) What partners and stakeholders should we consider?

Baldwin commented that Pew works on a wide range of topics and that they will be beneficial in the future. He expressed that partnering with Pew would be good and would love to see Pew work on the CHPP and that this would be a great relationship.

Emory stated that the key messages are the particular topics up for action. Any general awareness paves the way to action. The public is big and who in the public to target? We want the conservation organizations to be aware of the CHPP. We want the local government to be aware of the CHPP. We need to keep the CHPP in front of the decision makers. There are some key people that should be on the radar.

Posey agreed and the public needs to know the importance of protecting habitat and why the CHPP is important to their lives. Listening to different angles and viewpoints of the public is critical to get the public knowledgeable and supportive. The opportunity is still there to have conversations with members and to educate the right people.

NC Blue Crab Fisheries Management Plan; Water Quality Recommendations

Corrin Flora (DMF) presented to the CHPP Steering Committee the MFC-approved management measures in Amendment 3 to the Blue Crab FMP issue paper on water quality concerns. Concerns due to mass mortality events in peeler operations, mortality during hypoxic concerns, effects of endocrine disruptors, and quality habitat were addressed in the issue paper. Of the seven management measures, #4 concerns the CHPP Steering Committee directly which is to task the CHPP Steering Committee to prioritize blue crab water quality impacts and juvenile habitat impacts. These should include hypoxia and toxins, while researching specific sources of water quality degradation and their effects on blue crabs. Discussion centered around how the current issue papers that will be included in the 2021 CHPP Amendment will meet expectations of Task #4 and can include wording to link the paper to the Blue Crab FMP.

Posey asked if the water quality measures that are being proposed as well as the restoration and protection of marsh was a way to address management measure #4. Flora stated that it would. One of the first places that blue crab settle is SAV, using wetlands later in their life history or where SAV is not available. Posey suggested that the Blue Crab FMP and stock assessment be referenced in both the SAV and the wetland issue papers. Knight and Murphey said that it could be done and could potentially reference other managed fishery species where SAV is important to their life histories.

ISSUES FROM COMMISSIONERS

Johnson asked if there were any issues from the commissioners. Baldwin stated that one hot issue is WRC re-designating coastal waters, which would take areas out of CAMA jurisdiction. He expressed concern over management by different agencies and how it will become fractured. He asked about an update.

Katy West (DMF) stated that each agency has been moving forward with the rulemaking process. MFC met in August 2019 where the boundaries rules were acted on and approved with no public comment. She has not seen WRC rules yet go through the same review. However, there will be a new executive director beginning August 1.

Baldwin stated that the CRC sent a letter objecting to the rules and that when different agencies do not agree, it will end up on the Governor's desk. He requested that an update on this be an agenda item for the next meeting.

Johnson brought up the issue concerning the chairmanship of the CHPP Steering Committee. In the past, the committee was chaired by one of the commissioners and DEQ staffed the committee. Over time, he has asked for volunteers but for the last few years, no one was comfortable being the chair, so he has run the meetings. Johnson talked to Posey and asked if he would be interested in assuming the chairmanship. Posey agreed, pending committee approval/agreement.

Motion by Larry Baldwin to nominate Martin Posey as chair of the CHPP Steering Committee. Seconded by Bob Emory. Motion carries unanimously.

NEXT MEETING DATE (OCTOBER)

Johnson stated he will be looking at October for another meeting and will begin looking at date options.

ADJOURN

/plm

ROY COOPER
Governor
MICHAEL S. REGAN
Secretary

NORTH CAROLINA
Environmental Quality

MEMORANDUM

TO: Coastal Resources Commission
Environmental Management Commission
Marine Fisheries Commission
Coastal Habitat Protection Plan Steering Committee

FROM: Jimmy Johnson
Albemarle-Pamlico National Estuary Partnership
Anne Deaton
Division of Marine Fisheries

DATE: October 29, 2020

SUBJECT: Coastal Habitat Protection Plan Steering Committee Meeting

The Coastal Habitat Protection Plan Steering Committee met via webinar at 9:00 a.m. Friday, October 16, 2020. The following attended:

Commissioners: Martin Posey, Pete Kornegay, Bob Emory, Larry Baldwin, David Anderson, Yvonne Bailey

DMF Staff: Dan Zapf, Anne Deaton, Casey Knight, Alan Bianchi, Jason Rock, Kacee Zinn
APNEP Staff: Bill Crowell, Jimmy Johnson, Trish Murphey, Tim Ellis, Dean Carpenter
DCM Staff: Mike Lopazanski,
DWR Staff: Forest Shepard, Rich Gannon, Jim Hawhee, Karen Higgins, Amanda Mueller
DEMLR Staff: Samir Dumpor
NCDA&CS: Eric Pare (S&W)
Public: Paul Cough (APNEP), Kelly Garvy (The Pew Charitable Trust) Leda Cunningham (The Pew Charitable Trust), Todd Miller (NCCF), Phillip Todd (Atlantic Reef Maker), Mason Phipps, Rob Lamme (NCCF), Thomas Roller (MFC), Wilson Laney (NCSU/APNEP/NCWF), Liz Rasheed (SELC), M. Bruce, Marion Deerhake (EMC), Melissa Whaling (SELC), Hans Paerl (UNC-IMS), Jud Kenworthy (APNEP), Carol Price (NC Aquariums), Carolyn Currin (NOAA-NCCOS), D. Childers

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WELCOME, INTRODUCTIONS AND APPROVE AGENDA

Martin Posey (Chairman), welcomed everyone on the webinar and asked them to sign in through the chat including their affiliation and favorite Halloween candy, in order to get a list of attendees. He asked that everyone hold questions and comments until the end of each presentation. No changes to the agenda were requested.

APPROVE MINUTES FROM JULY 30, 2020 MEETING

Motion by Larry Baldwin to approve the minutes. Seconded by Yvonne Bailey. Motion approved by acclamation.

UPDATED TIMELINE

Jimmy Johnson (APNEP) reviewed the updated timeline of the 2021 CHPP amendment. Johnson had discussed the amendment completion date with DEQ directors and all agreed to the need to extend it to allow adequate incorporation of information and review. The new timeline has been extended to the fall of 2021 for completion of the plan and approval by the three commissions. He provided a short update on where each issue paper is within the timeline and which issue papers are left for review by the steering committee. Johnson noted that following completion of the amendment, a public friendly summary document will be developed.

Johnson also informed the steering committee that there will a short update on the CHPP at each of the upcoming commission meetings. He offered this could be done by that staff or a steering committee member from his/her respective commission. Posey offered to work with Pete Kornegay to update the MFC. Bob Emory offered to update the CRC and Yvonne Bailey will work with the EMC. Johnson will work with each steering committee member on the update. Staff will send meeting minutes and the new timeline to the steering committee.

REVIEW OF WETLAND WORKSHOP SERIES

Deaton provided a summary on the wetland workshop series held in August. This series of three workshops brought together the technical community to provide input and guidance for the wetland issue paper. There were approximately 50 attendees for each workshop. The first workshop focused on mapping and monitoring. Presentations were given on current mapping of wetlands and the use of remote sensing for the mapping and monitoring of wetlands. The second workshop was about threats and conservation, where the group heard about concerns regarding changes to the federal definition of Waters of the United States (WOTUS), especially to the state's palustrine wetlands, as well as wetland loss occurring from a variety of sources. The third workshop was about restoration and living shorelines where they heard about different restoration techniques and about the successes of living shorelines in NC. A summary document has been drafted and is in review. It will be provided to the steering committee. These workshops were very helpful and will provide good direction for the wetland issue paper.

UPDATE ON ISSUE PAPERS IN PROGRESS

Wetland Protection and Restoration with Focus on Nature-Based Methods

Deaton provided an update on the wetland issue paper for Curt Weychert (DCM), who is lead for this paper, but unable to attend. The wetland workshops provided useful information that will be incorporated into the issue paper. A lot of work has been compiled for the background section, with assistance from Chris Ballie (ECU). Staff are just beginning the discussion section, which will include potential actions and policies to address wetland issues.

Baldwin thought the goals and objectives of the CHPP are good but money and funding sources are needed for making progress. Baldwin stated there are sources available for the enhancement and creation of wetlands. Division of Mitigation Services can direct people to funding. There are private mitigation banks but not so much on the coast. He said mitigation needs to be encouraged in the CHPP. There is mitigation in the mountains and for streamside management zones. Deaton stated that the workshop had some discussion on mitigation and there are challenges that currently limit mitigation on the coast.

Reducing Inflow and Infiltration to Improve Water Quality

Deaton noted that the issue paper is nearing completion and that the three commissions were provided an overview at their August and September meetings. Good feedback was received, especially from the EMC commissioners. The CHPP writers received data from DWR which shows the extent of sanitary sewer overflow in coastal counties and highlights the connection to coastal water quality. This paper should be available for your review at the next meeting.

Habitat Monitoring to Assess Status and Regulatory Effectiveness

Casey Knight (DMF) provided an update on this issue paper. The focus of the paper is on the status and trends of the six coastal habitats and the monitoring needed to identify changes in the system that will make management more effective. The paper is evolving with help from DMF staff regarding the shell bottom and hard bottom sections. She is currently working on the water column and soft bottom sections. The wetland and SAV monitoring sections will be consistent with the content of the SAV and Wetland issue papers. Knight is coordinating with DWR and DCM to obtain water quality and coastal wetland data. Knight is also working with the APNEP SAV low and high salinity monitoring subgroups that are developing their monitoring plans.

Chairman Posey asked if in the soft bottom section, there will be consideration of different sediment types or done as one unit. Knight stated that she has not addressed that yet and that in the 2016 CHPP it was one overall component. However, she has been reviewing literature and considering ways to take into account consideration of the different sediment types.

SAV Issue Paper and Recommendations

Trish Murphey (APNEP) provided an update on the latest draft of the SAV issue paper. The background section was updated to reflect the steering committee recommendation to reference the Blue Crab Fishery Management Plan (FMP) and its management action for the CHPP Steering Committee to make blue crab water quality a priority. In addition, a table was added listing all FMPs that have SAV and/or water quality recommendations as they relate to this issue paper. The issue paper recommendations were also updated to reflect the steering committee recommendation to be more clear and concise on the issue paper recommendations. These latest recommendations were further reviewed by division directors and DWR staff. The last change in the issue paper addressed concerns voiced by the steering committee as well as the CRC and EMC on how dynamic SAV can be naturally and how this may impact the interim SAV acreage goal. Murphey explained that by improving water quality, the trend toward that goal should increase and also make the SAV more resilient to natural stressors. She also provided a brief update on the SAV Technical Workshop that was held in March and was used to inform the SAV issue paper.

Chairman Posey asked about sending any comments on the latest version of the issue paper. Murphey replied to send any comments or edits to the paper to Casey Knight and herself.

Bob Emory asked about the nutrient loads in the Neuse River Basin since nutrients are such an issue for SAV. He had concerns that the nutrient levels have not improved in the basin and wanted to know if it is true that nitrogen levels have increased. Rich Gannon (DWR) confirmed this and provided an explanation on potential reasons for lack of improvement in the Neuse River Basin.

Baldwin followed up on Emory's observation. He discussed that a lot of money was spent on upgrading wastewater treatment plants (WWTPs). Nutrient levels did not decrease but stayed steady. He also questioned the SAV "starting point" as a metric. The starting point, will make a difference and is important to consider. He noted there have been changes in coastlines, inlets, and waterbody salinities. This can impact where SAVs can occur.

Knight agreed with Baldwin and noted that when working with the SAV team, the group was cautioned on how far back to go historically. We need to be realistic and therefore, the issue paper settled on the most recent historical record (1981-2015). Also, by breaking up the coast into regions, we will be able to address the different areas as we gather more data on a regional basis. We can continue to update our data as we move forward.

STATUS OF SAV IN ESTUARINE WATERS OF NC*

Jud Kenworthy (APNEP) presented to the steering committee about SAV in NC. He discussed the monitoring of SAV and that we are seeing more declines than gains because of water quality and its impacts on water clarity. The system is not at carrying capacity and will likely be in need of restoration. The question of baseline, discussed earlier will be a challenge. He supported the recommendations in the SAV issue paper and stated they will help avoid negative changes, and help us stay ahead of the curve in protecting SAVs. He discussed the value of SAV and that it is estimated to provide 12.5 billion dollars per year in ecosystem services. How salinity and temperature can impact species composition was discussed, and differences between the low and high salinity SAVs were described. He then reviewed the high salinity SAV trends and said we are now observing many previously continuous beds in high salinity areas convert to patchy beds. Kenworthy then discussed the monitoring of SAVs in the low salinity areas and how it is more difficult to monitor because of TSS, chlorophyll *a*, CDOM (colored dissolved organic matter) and other things that are encountered in low salinity areas that are not in the high salinity areas. The rapid assessment surveys and the use of sentinel sites were described. He discussed climate change and its impacts on SAVs.

Emory asked about declines of SAV in the Sandy Point area. Kenworthy explained that as nitrogen, and chlorophyll *a* increased, light availability to the plants decreased. This can be exacerbated by cyanobacteria blooms.

**Kenworthy presentation included an updated percentage of loss of SAV in the low salinity data. The issue paper will be updated with the new information.*

Chairman Posey asked if *Ruppia* and *Halodule* will be able to keep up with climate changes. Kenworthy explained that he would expect *Halodule* to take over. Because *Ruppia* can be very abundant and occurs in a broad range of environmental conditions, it may be important in the future. The group also discussed species shifts in both SAV and in aquatic life that use the SAV.

BREAK

Chairman Posey called a 10-minute break.

NC SALT MARSHES: THREATS AND CONSERVATION NEEDS

Carolyn Currin (NOAA-NCCOS) presented information on threats and conservation needs of salt marsh and the importance they are in providing fish habitat, water quality enhancement, recreation opportunities, and storm protection. However, their extent is declining, due to the primary threats of marsh dieback during drought, erosion from wave energy, drowning due to sea level rise (SLR), and loss associated with coastal development. The lack of updated maps of NC marsh extent at the resolution needed makes tracking precise change in marsh extent difficult.

Currin discussed how drought has been linked to large marsh diebacks in the southeast U.S. and is predicted to increase in severity in the future. Observed marsh diebacks in NC have been linked to periods of drought, and can persist for a decade with high marsh, and marshes with limited tidal exchange, are most vulnerable.

Currin also discussed SLR and the predicted rate of SLR in the next century will inundate much of the current NC marsh extent. Marshes can adapt to SLR by two mechanisms; either by increasing their surface elevation at a rate similar to SLR or by migrating inland to occupy flooded lowlands. Studies of marsh surface elevation change in central NC show that about half of the 54 marsh sampling stations were able to add elevation similar to the long-term SLR rate of 3 mm/yr. However, only 2 sites had marsh stations that were able to keep up with the accelerated SLR rate. In these two cases, both were able to keep up with greater sediment inputs due to proximity to an inlet or location behind a sill in a high-energy site. She stated that sediment is key and most marshes do not have a good sediment supply.

Currin discussed marsh migration and the need to learn more about the process. An assessment of marsh habitat extent by Duke University modelers suggests that under low to moderate rates of SLR over the next 80 years, much of the current marsh locations will convert to open water. However, marsh migration into uplands can result in maintaining marsh extent, except under the highest SLR scenarios. Yet, this cannot occur unless migration corridors are available. Marshes rely on an external supply of sediment to increase elevation, allowing marshes to grow upward or facilitate migrating landward. She discussed erosion rates in NC and the relationship of fetch, with lower fetch areas having lower erosion rates. She noted that marsh vegetation reduces shoreline erosion rates but does not prevent it. Marshes in high fetch areas have less vegetation, which results in erosion and undercutting on the banks. Daily wave energy during low tides is a greater cause of marsh erosion than periodic large storm events, since water levels during storm events are generally high and pass over marsh, rather than scouring the marsh base. Storms are the primary way that sediment can get into the marsh. Right now there is not enough marsh to trap the sediment to maintain themselves, so conservation measures or management to ensure marsh migration are critical as sea level rises.

Currin concluded with some discussion of the use of living shorelines as a conservation measure. They are more widely used today than in the past. They do reduce erosion but can be a bit of a band aid. They will not protect large marsh systems. Beneficial use of dredge material is another approach is to keep sediment in the system to support marsh accretion. The identification and maintenance of marsh migration corridors is another important approach.

Emory stated that for SAV, total suspended solids (TSS) is the problem while the lack of TSS is the problem for marshes, and asked if someone could address this apparent conflict. Kenworthy stated that SAV is not naturally present in intertidal areas while marsh is and can only survive in the intertidal zone. Lack of suspended solids is good for SAV but it decreases the ability for marsh to accrete. He also noted that chlorophyll *a* levels were more problematic for SAV than TSS. Chairman Posey asked if TSS decreases, should we assume this is deleterious to the marsh? Currin noted that in general yes. However, Amanda Mueller (DWR) pointed out that the source, type, and location of sediment, and relative proximity to wetlands and SAV matters. For palustrine and fringing estuarine wetlands, there is sediment from upland sources, allowing wetlands to migrate upward and landward. The presence of marsh will trap sediment, benefitting subtidal SAV. Sediment input lower in the system is also needed for salt marsh. The reason for insufficient sediment in the lower estuary was not known and there was interest in discussing it further.

NUTRIENT MANAGEMENT STRATEGIES IN NC

Gannon presented information on nutrient management in NC. He reviewed the early nutrient management actions and talked about the phosphate detergent ban in 1988. This was considered a successful regulatory action. That, together with previous establishment of a chlorophyll *a* standard, Nutrient Sensitive Water (NSW) classification, point source controls, and agricultural BMPs, successfully reduced nitrogen and phosphorus loads in the Chowan River. However, mean summer chlorophyll *a* levels have slowly increased since those measures were put in place in the late 1970s and 1980s. The Clean Water Act (CWA), requires that the EMC set reduction goals for nutrient-impaired waters, establish plans for fair and reasonable reductions from point and nonpoint sources, and implement TMDLs. Modeling is done to determine the goals and reduction allocations. He discussed what drives algal events, their effects, nutrient sensitive water (NSW) criteria, and point source strategies. He reviewed the nutrient management strategies that include rules to address wastewater, agriculture, riparian buffer protection, new and existing stormwater, and nutrient trading. Gannon also discussed stormwater rules for new development and how agricultural reductions are implemented. He reviewed the impairment history of the Neuse and Pamlico rivers. 2014 chlorophyll *a* impairment data in the Pamlico River showed improvement in the mid-estuary, but it's uncertain why or how permanent that is.

Gannon reviewed the trends in nitrogen levels in the Chowan River where organic nitrogen was a problem. It was unclear what the problems were and it was suggested that there are larger forces at play. He updated the steering committee on the draft Chowan River Basinwide Plan, which is currently out for public comment and should be approved by next year. There are several recommended actions that include voluntary measures as well as regulatory measures.

Gannon then discussed the process for the Nutrient Criteria Development Plan (NCDP) and the pilot programs within it. The NCDP has selected the Albemarle Sound and Chowan River as their estuarine waters pilot. Through this process they will reevaluate response criteria to nutrients and whether nitrogen or phosphorus numeric criteria are needed. They have selected SAV as a biological endpoint. The timeline is for the Scientific Advisory Committee (SAC) to provide final recommendations to the EMC by mid-2022 and have rulemaking complete by 2024. The CHPP Team will be coordinating with this effort to accomplish several of the key recommended actions in the SAV issue paper.

Emory asked about the success of Chesapeake Bay with nitrogen reduction and why NC did not have the same success. Gannon explained that Chesapeake Bay has been at it much longer and has much more resources than NC. Emory asked what the potential factors might be that are preventing the Neuse River water quality from improving. Hans Paerl (UNC-IMS) stated that another factor that impacts nutrient levels in NC is the frequency of storm events since the late 90s. From these storms, you see large pulses of nutrient loads as organic matter from multiple sources is flushed out. Increased frequency of heavy rain events and storms has led to increased flashiness of streams and creeks. Researchers are looking at the issue with NCSU to trace nutrient sources. Johnson mentioned the new Memorandum of Understanding (MOU) between NC and Virginia which hopefully this will lead to collaboration across the state lines.

Kenworthy asked about data for chlorophyll *a* and if any analysis has been done for Albemarle Sound. Gannon stated that there is chlorophyll *a* data that can support a determination. Currently, the sounds are meeting the chlorophyll *a* standard, despite frequent algal blooms. Jim Hawhee (DWR) stated that there is no phosphorus criteria but we have DO, pH, and chlorophyll *a* criteria. Baldwin stated that you need to have some information as a starting point and asked if anyone knew why organic nitrogen was changing. Gannon said they did not really know. Since the number of wastewater treatment plants are declining due to alternative methodology (land application) organic nitrogen may be more land-based and climate may be playing a role. In the Chowan system, high nitrogen levels occur near the lower southwest shoreline, and chlorophyll *a* is high in the upper river from near the Virginia border to around Winton. Between these two areas, levels are lower as algae take up nutrients. Marian Deerhake asked about the role of legacy sediments in fueling nitrogen levels. She noted that stream destabilization from development carries sediment downstream, and this is not addressed by stormwater rules.

Johnson gave a short update on the reclassification of the joint fishing waters. Johnson was told by WRC staff that there has been no further action. Wildlife Resources Commission has a new executive director and he is probably getting up to speed. The timeline for rules to go into effect is 2022.

PUBLIC COMMENT
No public comment.

ISSUES FROM COMMISSIONERS
No issues from commissioners

ADJOURN
Johnson will send out *information* regarding the date of the next meeting. **Motion by Pete Kornegay to adjourn. Seconded by Larry Baldwin. Motion approved by consensus.**

/plm

FISHERY MANAGEMENT PLANS

FMP STATUS UPDATE MEMO

ESTUARINE STRIPED BASS FMP UPDATE

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ROY COOPER
Governor

MICHAEL S. REGAN
Secretary

STEPHEN W. MURPHEY
Director

Oct. 30, 2020

MEMORANDUM

TO: N.C. Marine Fisheries Commission

FROM: Corrin Flora, Fishery Management Plan Coordinator
Fisheries Management Section

SUBJECT: Fishery Management Plan Update

Issue
Update the Marine Fisheries Commission (MFC) on the status of ongoing North Carolina fishery management plans (FMPs).

Action Needed
For informational purposes only, **no action is needed at this time**.

Overview
This memo provides an overview on the status of the North Carolina FMPs for the November 2020 MFC business meeting.

As noted at the MFC 's August 2019 business meeting, before the initial development of a draft FMP amendment, a scoping period will be held to notice the public that the review of the FMP is underway, inform the public of the stock status (if applicable), solicit input from the public on the list of potential management strategies to be developed, and recruit advisers to serve on the FMP advisory committee. The scoping process is concluding for estuarine striped bass and will be used for all future FMP reviews.

Southern Flounder FMP
The MFC adopted Amendment 2 to the Southern Flounder FMP at its August 2019 business meeting and actions were taken to address the overfished and overfishing status of the southern flounder stock as determined by the 2019 coast-wide stock assessment. The season closures implemented under the authority of Amendment 2 were deemed critical to address overfishing and the successful rebuilding of the southern flounder stock, while other more comprehensive, long-term management strategies are examined and developed in Amendment 3.

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The Southern Flounder FMP Advisory Committee is assisting the division with development of Amendment 3 to continue rebuilding the stock. Lead staff will provide a summary overview of progress at the November 2020 MFC business meeting on the progress of draft Amendment 3.

Shrimp FMP

Staff continue to develop the first draft of the Shrimp FMP Amendment 2. The division is examining management strategies to promote habitat protection, further reductions of non-target species bycatch in the shrimp trawl fishery, and potential changes to existing shrimp management strategies adopted in previous plans. At its February 2020 business meeting, the MFC received a summary of the public comments submitted, received an overview of the potential management strategies and the FMP timeline, and approved the goal and objectives for Amendment 2. The goal adopted by the MFC is to manage the shrimp fishery to provide adequate resource protection, optimize long-term harvest, and minimize ecosystem impacts. Advisory Committee appointment process will begin before the end of the year.

Estuarine Striped Bass FMP

The Estuarine Striped Bass (ESTB) FMP Plan Development Team recently completed the review of Amendment 1 and released the Central Southern Management Area (CSMA) Stock Report and the Albemarle-Roanoke River (A-R) Stock Assessment Report in August 2020. During the review process adaptive management under the current management plan, Amendment 1, was triggered, resulting in a Revision to Amendment 1. At the November 2020 MFC business meeting, lead staff will provide an overview of the Amendment 1 FMP review, including the CSMA and the A-R stock reports, and the recent Revision to Amendment 1.

With the review of Amendment 1 complete, development of Amendment 2 is underway, beginning with the scoping period being held Nov. 2-15, 2020. Results of the scoping period, the draft Goal and Objectives of Amendment 2, and a request for any additional management strategies to be considered, will be brought before the MFC at the Feb. 2021 business meeting.

Spotted Seatrout FMP

A benchmark stock assessment for spotted seatrout is underway coinciding with the scheduled Spotted Seatrout FMP review. The prior stock assessment from 2014 indicated that the stock is not overfished and is not experiencing overfishing. The Spotted Seatrout FMP Plan Development Team revisited the Data Workshop in October and incorporated data through 2019 to be more reflective of recent fishing activity. The benchmark stock assessment will be completed in 2021.

Striped Mullet FMP

A benchmark stock assessment for striped mullet is underway coinciding with the scheduled Striped Mullet FMP review. The stock assessment update through terminal year 2017 indicated that the stock is not experiencing overfishing. Due to a poor relationship between spawning stock biomass and juvenile abundance, overfished status was unable to be determined. The Striped mullet FMP Plan Development Team will meet in Dec. 2020 for the stock assessment Planning Workshop.

NORTH CAROLINA FISHERY MANAGEMENT PLANS
Nov. 2020

Striped Bass

- Division holds public scoping period
- Marine Fisheries Commission approve goal and objectives of FMP

Shrimp

- Division draft FMP
- Division hold workshops to further develop draft FMP with plan advisory committee

Southern Flounder

- Division update draft plan for Marine Fisheries Commission presentation
- Marine Fisheries Commission vote to send draft FMP for public and advisory committee review
- Commission advisory committees meet to review draft FMP and receive public comment
- Marine Fisheries Commission select preferred management options
- Department of Environmental Quality secretary and legislature review draft FMP
- Marine Fisheries Commission vote on final adoption of FMP
- Division and Marine Fisheries Commission implement management strategies

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State of North Carolina | Division of Marine Fisheries
3441 Arendell Street | P.O. Box 769 | Morehead City, North Carolina 28557
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ESTUARINE
STRIPED BASS FMP

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ROY COOPER
Governor

MICHAEL S. REGAN
Secretary

STEPHEN W. MURPHEY
Director

Oct. 23, 2020

MEMORANDUM

TO: N.C. Marine Fisheries Commission

FROM: Yan Li, Stock Assessment Scientist
Todd Mathes, Biologist, Estuarine Striped Bass FMP Co-Lead
Fisheries Management Section

SUBJECT: Central Southern Management Area Estuarine Striped Bass Stocks Report

Issue

During review of the N.C. Estuarine Striped Bass Fishery Management Plan (FMP) began by DMF and Wildlife Resources Commission (WRC), staff conducted an evaluation of Central Southern Management Area (CSMA) striped bass stocks. The results will inform development of Amendment 2. This memo provides a summary of key findings for the CSMA striped bass stocks that were based on the major analyses conducted by the division.

Action Needed

For informational purposes only, **no action is needed at this time.**

Findings

After reviewing available data, life history information, and stock assessment techniques, it was determined traditional stock assessment models are not appropriate for CSMA stocks because of the high hatchery contribution and lack of natural recruitment in these systems. A demographic matrix model was developed to evaluate different stocking and management measures for striped bass in all three CSMA river systems and an additional tagging model was developed to estimate striped bass abundance in the Cape Fear River.

The CSMA Estuarine Striped Bass Stocks report is a collection of (1) all data that have been collected, (2) all management effort, and (3) all major analyses that have been completed for CSMA stocks to serve as an aid in development of Amendment 2. As such:

- **Stock status could not be determined for CSMA striped bass.**
- **No biological reference points were generated for CSMA striped bass.**

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Matrix Model Overview - Tar-Pamlico, Neuse, and Cape Fear rivers

- Matrix model results indicate striped bass populations in the CSMA are depressed to an extent that sustainability is unlikely at any level of fishing mortality, given the current model assumptions.
- Survival and fertility of young fish influenced population growth rate more than older fish.
- Older fish contributed more than younger fish to reproduction due to higher egg production.
- Simulation of stocking and fishing strategies showed the population would likely benefit from stocking more fish.

Tagging Model Overview - Cape Fear River

- Results showed a consistent decline in striped bass abundance in the Cape Fear River from 2012–2018.
- Abundance in 2018 was reduced to less than 20% of the abundance in 2012, even with a total no-possession provision for Cape Fear River striped bass since 2008.

For more information, please refer to the full documents included in the Briefing Materials:

- Central Southern Management Area Striped Bass Stocks in North Carolina, 2020

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Central Southern Management Area Striped Bass Stocks in North Carolina, 2020

T. Mathes, Y. Li, T. Teears, and L.M. Lee (editors)

August 2020

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ACKNOWLEDGEMENTS

Members of the North Carolina Division of Marine Fisheries (NCDMF) Striped Bass Plan Development Team and their counterparts at the North Carolina Wildlife Resources Commission (NCWRC) were invaluable in providing assistance for the development of this stock assessment. Plan Development Team members from the NCDMF are Charlton Godwin (co-lead), Todd Mathes (co-lead), Katy West (mentor), Drew Cathey, Sean Darsee, David Dietz, Joe Facendola, Daniel Ipock, Laura Lee, Yan Li, Brian Long, Lee Paramore, Jason Peters, Jason Rock, Scott Smith, Chris Stewart, Thom Teears, Amanda Tong, Curt Weychert, and Chris Wilson. Members from the NCWRC are Jessica Baumann, Courtney Buckley, Kelsey Lincoln, Jeremy McCargo, Katy Potoka, Kyle Rachels, Ben Ricks, Kirk Rundle, Christopher Smith, and Chad Thomas. Thanks also to Kathy Rawls, NCDMF Fisheries Management Section Chief, and Catherine Blum, NCDMF Fishery Management Plan and Rulemaking Coordinator.

EXECUTIVE SUMMARY

The North Carolina Fisheries Reform Act requires that fishery management plans be developed for the state's commercially and recreationally important species to achieve sustainable levels of harvest. Stock assessments are the primary tools used by managers to assist in determining the status of stocks and developing appropriate management measures to ensure the long-term viability of stocks.

This report represents a joint effort between the North Carolina Division of Marine Fisheries (NCDMF) and the North Carolina Wildlife Resources Commission (NCWRC). A working group of modelers, university researchers, and fishery biologists were brought together to review available data and to develop analyses that would address current management and research interests of Central Southern Management Area (CSMA) striped bass. The CSMA includes three major river systems: the Cape Fear, the Neuse, and the Tar-Pamlico. No stock status determination was performed for CSMA striped bass in this report and biological reference points were not generated due to continuous stocking effort and lack of understanding on the abiotic factors that are hindering the successful natural recruitment given the large number of fish stocked every year. This report is intended to be a collection of (1) all data that have been collected, (2) all management effort, and (3) all major analyses that have been completed for CSMA stocks. This report serves as a record of completed research efforts with implications for fishery management, and as a guide for future research effort based on results and identified data gaps.

A demographic matrix model was developed for striped bass in the three river systems in the CSMA. The matrix model was parameterized by synthesizing existing knowledge and data regarding striped bass, particularly the striped bass in the CSMA, from a literature review, data review and expert opinions. The population growth rate and the relative importance of life history parameters of each age group was estimated and evaluated. The demographic matrix model does not provide population abundance or mortality estimates. Possible stocking and fishery management strategies were evaluated using this matrix model. A tagging model was developed for striped bass in the Cape Fear River using tagging data collected by the NCDMF from 2012 to 2018. The total mortality and annual abundance for age 3–7 striped bass in the Cape Fear River were estimated by the tagging model.

Results from the matrix model indicated that striped bass populations in the CSMA are depressed to an extent that sustainability is unlikely at any level of fishing mortality, especially the assumptions associated with longevity (7 years for Cape Fear River and 11 years for Neuse and Tar-Pamlico Rivers) and age-0 survival (0.000017). Population growth rate was more dependent on survival and fertility of young fish than old fish. Reproductive contribution was most influenced by older age-classes due to higher fertility. Fishing activities typically select larger fish; thus, increases in fishing mortality disproportionally impact the abundance of older fish, constrict the age structure of the population, and limit reproductive contribution. Simulation on stocking and fishing strategies showed that population would likely benefit more from stocking more fish. Among the fishing strategies tested, the 10-year closure was most effective in increasing adult (age 3+) abundance over the entire 15-year simulation time period, and was also most effective in increasing old adult (age 6+) abundance during the first 13 years of simulation. Abundance of older fish (age 6+); however, quickly declined after the 10-year closure ended, and the 10-year closure strategy became less effective than the combo strategy in no stocking scenario, and less

effective than both the 26-inch size limit strategy and the combo strategy in stocking scenarios during the last two years of simulation.

Results of the tagging model showed a consistent decline in abundance estimates for striped bass in the Cape Fear River from 2012–2018. Abundance in 2018 was reduced to less than 20% of the abundance in 2012, even with a total no possession provision for striped bass in place in the Cape Fear River since 2008.

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1 INTRODUCTION

1.1 The Resource

The common and scientific names for the species are striped bass, *Morone saxatilis* (Walbaum; Robins et al. 1991). In North Carolina, it is also known as striper, rockfish, or rock. Striped bass naturally occur in fresh, brackish, and marine waters from Canada to the Gulf of Mexico. Due to their annual spawning migrations into freshwater, striped bass have been the focus of fisheries from North Carolina to New England for several centuries and have played an integral role in the development of numerous coastal communities. Striped bass regulations in the United States date to pre-Colonial times (circa 1640) when striped bass were prohibited from being used as fertilizer. Striped bass populations south of Cape Hatteras, North Carolina are considered to have a primarily endemic riverine life history, having limited or no adult oceanic migration (Setzler et al. 1980; Rulifson et al. 1982a; Callihan 2012).

Various levels of stocking have occurred in the Central Southern Management Area (CSMA; Tar-Pamlico, Neuse and Cape Fear rivers) since the 1940s (Bayless and Smith 1962; Woodroffe 2011), with the North Carolina Division of Marine Fisheries (NCDMF's) formal involvement beginning in 1980 as a result of a cooperative agreement with the United States Fish and Wildlife Service (Table1.1; NCDMF and NCWRC 2013). The North Carolina Wildlife Resources Commission (NCWRC) was added to the cooperative agreement in 1986 (NCDMF 2013) but has been involved in the CSMA striped bass stocking program since fry stocking began in Neuse River tributaries in 1949 (Bayless and Smith 1965). The practice of cross-stocking (stocking of striped bass from one drainage system to another, e.g., Roanoke River striped bass offspring being stocked throughout the southeastern United States) has introduced non-endemic genetic strains to many striped bass populations. The effects of this long-standing practice remain largely undocumented and unquantified (Rulifson and Laney 1999; Bergey et al. 2003).

A management strategy adopted in the North Carolina Estuarine Striped Bass Fisheries Management Plan (FMP) Amendment 1 continued the annual stocking program in the CSMA rivers. Specific objectives for stocking striped bass included attempts to increase spawning stock abundance while promoting self-sustaining population levels appropriate for various habitats (see Amendment 1, Section 11.2 Striped Bass Stocking in Coastal Rivers, NCDMF 2013). The management strategy from Amendment 1 increased the annual numbers stocked to a goal of 100,000 hatchery reared striped bass in each of the major river systems (Tar-Pamlico, Neuse, and Cape Fear rivers) to aid in recovery of the stocks. From 2004 to 2009, stocking occurred on a rotating basis where only two out of the three systems were stocked annually. Prior to 2004, stocking was focused on the Tar-Pamlico and Neuse rivers with sporadic stocking in the Cape Fear River (Table 1.1).

Prior to 2010, the otoliths of hatchery-reared striped bass were chemically marked with oxytetracycline to determine the percent contribution of hatchery fish to the wild population. Results from the chemical marking methodology suggested hatchery-reared striped bass contributed little to the spawning populations in the CSMA (0 to 31%; Barwick et al. 2008); however, since the adoption of Amendment 1, researchers have realized the chemical mark was not being retained in 100% of fish (73%; Barwick et al. 2008), which led to underestimation of the percent of hatchery reared fish in the striped bass populations in the CSMA (Barwick et al. 2008; NCDMF 2013).

In 2010, the NCWRC implemented parentage-based tagging (PBT) as a more accurate method to determine percent hatchery contribution of the striped bass spawning populations in the CSMA. This method utilizes genetic marking techniques and has proven to be greater than 99% accurate at determining if an individual fish was hatchery produced or not (Denson et al. 2012). In 2016, the NCDMF started collecting striped bass fin clip samples for PBT analysis from the commercial and recreational fisheries and from areas away from the spawning grounds in the lower portions of the rivers to gain additional spatial coverage of samples. Since 2011, PBT analysis of samples collected on the spawning grounds and in internal coastal fishing waters of the Tar-Pamlico, Neuse, and Cape Fear rivers has revealed hatchery-stocked striped bass can comprise up to 90% of the fish sampled in some years (O'Donnell and Farrae 2017); however, PBT results from fish sampled in 2017 revealed a noticeable decrease in contribution of hatchery-stocked fish (Farrae and Darden 2018). In 2017 and 2018, percentages of hatchery fish were much lower for the 2014 and 2015 year classes in NCDMF samples (63% and 41%, respectively) and NCWRC samples (76% and 77%, respectively).

While attempts have been made to use catch curves to assess the stock status of CSMA striped bass (NCDMF 2004, 2013) no peer-reviewed stock assessment has been conducted. The catch-curve analysis conducted in 2003 determined the stock was experiencing overfishing (NCDMF 2004), although it was not used for management; however, a repeat of that analysis in 2010, concluded stock status could not be determined due to uncertainty in the mortality estimates (NCDMF 2013). Therefore, striped bass in the Tar-Pamlico and Neuse rivers have an unknown stock status. The need for continued conservation management efforts has been supported by persistent low overall abundance, minimal natural recruitment, multiple sources of mortality, the absence of older fish on the spawning grounds, non-optimal environmental conditions on the spawning grounds in the spring, potential impacts from stocked juveniles and hybrid striped bass, and the high percentage of stocked fish in the population in most years.

1.1.1 Stock Definitions

There are two geographic management units (northern and southern) and four striped bass stocks inhabiting the estuarine and inland waters of North Carolina. The CSMA is located in the southern geographic management unit and includes all internal coastal, joint, and contiguous inland waters of North Carolina south of the Albemarle Sound Management Area (ASMA) to the South Carolina state line (Figure 1.1). There are spawning stocks in each of the major river systems within the CSMA (Tar-Pamlico River stock, Neuse River stock, and Cape Fear River stock). Spawning grounds are not clearly defined in these systems as access to spawning areas is influenced by river flows and impediments to migration. Management of striped bass within the CSMA is the sole responsibility of the North Carolina Marine Fisheries Commission (NCMFC; coastal and joint fishing waters) and the NCWRC (joint and inland waters) and is not subject to compliance with the ASMFC Interstate FMP for Atlantic Ocean striped bass.

This report focuses on the analyses performed for the striped bass in the CSMA. After reviewing available data, life history information, and stock assessment techniques, it was determined traditional stock assessment models would not be appropriate for CSMA stocks because of the high hatchery contribution and lack of natural recruitment in these systems.

1.2 Life History

1.2.1 Movements & Migration

Striped bass populations in the Tar-Pamlico, Neuse, and the Cape Fear rivers have been considered to have a primarily endemic riverine life history having limited or no adult oceanic migration (Setzler et al. 1980; Rulifson et al. 1982a). Tagging data have indicated there is some movement of striped bass from the Neuse and Pamlico rivers into other systems and the Atlantic Ocean, but this is at low levels (Callihan 2012; Callihan et al. 2014; Rock et al. 2018). Tag-return data from stocked striped bass (Phase II; 5–7 inch total length, TL) suggest that these fish contribute to the commercial and recreational fisheries as well as the spawning stock in the Neuse and Tar rivers but do not commonly migrate to other rivers (Winslow 2007). Acoustic tagging studies within the Cape Fear River Basin demonstrated adult fish making seasonal spawning migrations within the drainage; however, emigration out of the system was minimal (Rock et al. 2018; Prescott 2019). Many striped bass exhibited a pattern of residency in the lower portions of the Tar-Pamlico and Neuse rivers with some detected making multiple seasonal spawning runs with many moving as far upstream as Rocky Mount in the Tar River and Raleigh in the Neuse River (Rock et al. 2018).

1.2.2 Age & Size

Striped bass scales have been collected by the NCDMF since 1975, and otoliths have been collected since 2003. Striped bass otoliths have been documented to provide more accurate and precise age estimates than scales (Humphreys and Kornegay 1985; Boyd 2011; Liao et al. 2013) and that ageing error can bias results of stock assessments. In 2017, the NCDMF compared scale and otolith ages from multiple readers for known age striped bass and found age estimates from scales to be unreliable and commonly underage or overage CSMA striped bass; as a result, only otolith ages are considered in this assessment (see section 7). Additionally, in 2016 and 2017 genetic samples were collected by the NCDMF from striped bass that allowed for age determination of hatchery-produced fish that were used in this analysis. The NCWRC used scales to age Tar-Pamlico River striped bass from 1996–2012 and Neuse River striped bass from 1994–2012. Since the inception of the PBT program in 2010, the NCWRC has determined ages of hatchery-produced fish using PBT analysis and used scales when PBT ages were not available. The NCWRC does not routinely collect striped bass otoliths, and did not provide any otolith ages for this assessment. Based on otolith and PBT age data collected from 2004 to 2017 (Figure 1.2), a maximum age of 11 years has been observed for striped bass in the Tar-Pamlico and Neuse rivers and a maximum age of seven years has been observed for striped bass in the Cape Fear River. Fish older than age eight years are rare in all of the CSMA river systems; however, NCWRC scale-aged fish suggest greater maximum ages in all CSMA rivers (Homan et al. 2010; Fisk and Morgeson 2016). This report found that ageing biases from scale ages resulted in underestimates of population abundance (15%) and female spawning stock biomass (19%), while overestimating fishing mortality in the terminal year (19%) and made strong age-1 recruitment years appear weaker and weak ones stronger.

1.2.3 Growth

As a relatively long-lived species, striped bass (approaching 30 years) can attain a moderately large size. Females grow to a considerably larger size than males; striped bass over 30 pounds are almost exclusively female (Bigelow and Schroeder 1953; NCDMF, unpublished data). Growth occurs between April and October. During the spawning migration, striped bass stop feeding for a brief period just before and during spawning, however feeding continues during the upriver spawning migration and resumes soon after spawning (Trent and Hassler 1968). From November through March, striped bass growth is thought to be negligible.

Striped bass in the CSMA grow at a faster rate and have a greater total length at age compared to the A-R stock (Knight 2015) and Neuse River striped bass exhibit the fastest growth rate in the CSMA (NCDMF 2020). As an example, in 2017, mean length of age-5 female striped bass in the Roanoke River was 559 mm TL while Neuse River female mean length at age 5 was 634 mm TL (Ricks and Buckley 2018; Smith and Potoka 2018). Fast growth in CSMA rivers has been attributed to a lack of density-dependent forage limitations (Ricks and Buckley 2018). This is possibly attributed to superior growth in the initial year of life for hatchery fish compared to wild fish, abundant food availability, and relatively small population. In addition, a tagging study showed striped bass stocked in the Neuse and Tar-Pamlico rivers had a higher growth rate (growth coefficient of 0.54–0.61 per year) than in their natal habitat (Roanoke River; Callihan et al. 2014).

1.2.4 Reproduction

Striped bass spawn in freshwater or nearly freshwater portions of North Carolina's coastal rivers from late March to June depending upon water temperatures (Hill et al. 1989). Spawning behavior is characterized by brief peaks of surface activity when a mature female is surrounded by up to 50 males as eggs are broadcast into the surrounding water and males release sperm, termed "rock fights" by locals (Setzler et al. 1980). Spawning by a given female is probably completed within a few hours (Lewis and Bonner 1966).

Based on data collected on the Tar-Pamlico River in 2004 and 2005, the peak spawning activity was observed in April through mid-May (Smith and Rulifson 2015) and acoustic detection data in the Neuse River shows striped bass were only in the upper portions of the river from March through May (Rock et al. 2018). Despite an apparent spawning migration, and NCWRC surveys that have documented limited numbers of striped bass eggs in various stages of development in the Tar-Pamlico and Neuse rivers (Jones and Collart 1997; Smith and Rulifson 2015), the stocks remain comprised of predominantly hatchery origin fish (Farrae 2019; Table 1.2).

Studies have collected eggs, larvae, juveniles (Winslow et al. 1983; Smith 2009; Smith and Hightower 2012; Morgeson and Fisk 2018), or adult fish (Ashley and Rachels 2006) to show evidence of spawning and/or spawning migrations in the main stem of the Cape Fear River.

1.2.4.1 **Eggs**

Mature eggs are 1.0–1.5 mm (0.039 to 0.059 inch) in diameter when spawned and remain viable for about one hour before fertilization (Stevens 1966). Fertilized eggs are spherical, non-adhesive, semi-buoyant, and nearly transparent. Fertilized eggs need to drift downstream with currents to hatch into larvae. If the egg sinks to the bottom, the chances of hatching are reduced because the sediments reduce oxygen exchange between the egg and the surrounding water. After hatching, larvae are carried by the current to the downstream nursery areas.

There is some discrepancy over temperature tolerance for striped bass eggs. Morgan and Rasin (1973) and Rogers et al. (1977) indicated that egg survival gradually declines as temperature drops below 17°C and rapidly declines as water temperature approaches 23°C. In general, lower temperatures lead to longer incubation periods (Hardy 1978). Bain and Bain (1982) documented

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hatching at approximately 48 hours after fertilization at a temperature of 18°C, and other studies have shown that hatching time varied from 29 hours at 22°C to 80 hours at 11°C (Mansueti 1958; Hardy 1978). Hassler et al. (1981) found that A-R striped bass eggs hatch in 38 hours. Sampling by the NCWRC in 1965 and 1975 indicated striped bass spawning occurs in the Tar-Pamlico River from mid-April to mid-May with peak egg production occurring from 18 to 21° C (Humphries 1965; Kornegay and Humphries 1975).

Smith and Rulifson (2015) collected striped bass in the Tar-Pamlico River from early March through mid-April in 2004 and 2005. The NCWRC surveyed striped bass eggs in the Tar-Pamlico River in 1996 and collected 1,366 striped bass eggs with 77.3% being identified as viable during sampling from April through May (Jones and Collart 1997). The NCWRC also collected 188 striped bass eggs from Fishing Creek, a tributary of the Tar-Pamlico River, of which 79% were identified as viable.

Numerous studies employing differing methodology have investigated the presence and viability of striped bass eggs in the Neuse River (Baker 1968; Hawkins 1980; Nelson and Little 1991; Burdick and Hightower 2006; Buckley et al. 2019). Eggs have been collected throughout the Neuse River and its tributaries, generally above Kinston, from the end of March through May. Eggs have been collected at all developmental stages with up to 65% viable eggs (Buckley et al. 2019).

A number of studies have examined the presence of striped bass eggs in the Cape Fear River using variable methodology (Smith 2009; Dial Cordy and Associates 2017; Morgeson and Fisk 2018). Eggs were generally collected from April and May despite sampling occurring in March, though there is generally low abundance of eggs in the river and very few eggs are captured above Lock and Dam 3. Most eggs have been collected below Lock and Dam 1, and collected eggs have been identified as being at multiple developmental stages, although Smith and Hightower (2012) found that the river section between Lock and Dam 2 and Lock and Dam 3 had the highest egg collections and highest predicted proportion of the run.

Research suggests the egg buoyancy of certain strains (e.g., Roanoke River and Chesapeake Bay) are adapted to specific flow conditions. Chesapeake Bay strain eggs are lighter and maintain their position in the water column of calmer tidal waters through neutral buoyancy, whereas Roanoke River strain eggs are heavier and use the more turbulent, high energy system of the Roanoke River to maintain their position in the water column (Bergey et al. 2003).

In 2017, North Carolina State University (CRFL# 2017-F-046) initiated research to provide insight into the current striped bass recruitment status by evaluating genetic and environmental influences on egg development. Preliminary results suggest that the heaviest eggs collected in 2018 and 2019 were from striped bass in the Tar-Pamlico and Neuse rivers (Cara Kowalchyk, NCSU, personal communication). It is interesting to note that the heaviest eggs in the study came from the shallowest river systems; the upper Tar-Pamlico River has an average width of 15 m and an average depth of 0.6 m in the upper reaches and an average width of 49 m and average depth of 4.6 m in the lower reaches (NCWRC 2006).

1.2.4.2 **Larvae**

The larval development of striped bass is dependent upon water temperature and is usually regarded as having three stages: (1) yolk-sac larvae are 5–8 mm (0.20 to 0.31 inch) in total length and depend on yolk material as an energy source for 7 to 14 days; (2) fin-fold larvae (8–12 mm;

0.31-0.47 inch TL) having fully developed mouth parts and persist about 10 to 13 days; and (3) post fin-fold larvae attain lengths up to 30 mm (1.18 inches) in 20 to 30 days (Hill et al. 1989). Researchers of North Carolina stocks of striped bass (primarily the A-R stock) divide larval development into yolk-sac and post yolk-sac larvae.

Over the past several decades, very few striped bass larvae have been collected in CSMA systems. In 2004 and 2005, Smith and Rulifson (2015) first collected striped bass larvae on the Tar-Pamlico River in early March, and collections continued through mid-May with peak spawning periods detected in April through mid-May. In the Neuse River, only one striped bass larva was collected during each sampling conducted in 1978, 1989, and 2017 (Hawkins 1980; Nelson and Little 1991; Buckley et al. 2019). Larvae (n=32) were collected by Burdick and Hightower (2006) between 8 April–28 May in 2003 and 19 April–12 May in 2004 when water temperatures ranged from 14°C to 28°C in the main stem of the Neuse River and its tributaries. In the Cape Fear River, larval striped bass have generally been captured between April and mid-May with water temperatures ranging 18.6°C–22.5°C. In 2006, larval sampling coincided with the egg collections described in section 1.2.4.1. Larvae were collected at sites downstream of LD-1 (n=1), upstream of LD-1 (n=2), and upstream of LD-2 (n=4). No larval striped bass were captured in 2007, however in 2008 larvae were captured at LD-1 (n=3), LD-3 (n=1), and at the Fayetteville site (n=1). Dial Cordy and Associates Inc. (2017) captured one newly hatched larva below LD-2 on 29 March 2017 when the water temperature was 17.6°C, and two larvae were captured at LD-2 in May. An additional survey for larval fish using quatrefoil light traps was completed May–June 2017 in the Cape Fear, Northeast Cape Fear, and Black Rivers (NCWRC, unpublished data). Although 70 trap nights (1 trap night=1 light trap fished overnight) occurred and over 18 species (155 individuals) were collected, no striped bass larvae or juveniles were collected.

1.2.4.3 **Juveniles**

Most striped bass enter the juvenile stage at about 30 mm (1.18 inches) TL; the fins are then fully formed, and the external morphology of the young is similar to that of the adults. For the A-R stocks, juveniles are often found in schools and associate with clean sandy bottoms (Hill et al. 1989) and there is evidence of density dependent habitat utilization, with juveniles being collected in the Alligator River and Stumpy Point, Pamlico Sound in late June when large year classes are produced by the A-R stock (NCDMF, unpublished data).

Little is known about juvenile striped bass within the CSMA. Historically, very few juveniles have been captured during NCDMF and NCWRC sampling. Seine and trawl surveys conducted by the NCDMF from 1977 to 1983 collected 37 juveniles in Tar-Pamlico River and 14 juveniles in the Neuse River (Hawkins 1980). The Cape Fear River was only sampled from July–December 1977 and June–September 1978; two striped bass were collected in July 1977.

The NCWRC conducted exploratory juvenile sampling in the Neuse River during 2006 and 2007. No juvenile striped bass were collected in 2006, and five juvenile striped bass were collected in 2007. Evaluation of oxytetracycline (OTC) tagging determined that three of these fish were of hatchery origin and the other two had no OTC mark and could have been wild produced fish (Barwick et al. 2008).

In 2017, exploratory juvenile abundance surveys were developed for the Tar-Pamlico, Neuse, and Cape Fear rivers using trawl and seine nets based on historical sampling locations. No striped bass have been collected in the Tar-Pamlico and Neuse rivers; however, a total of 24 juvenile striped

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bass were collected in the Northeast Cape Fear River in 2018 and an additional four were collected in 2019 (Program 100 Juvenile Abundance Survey).

Results from these sampling efforts support the hypothesis of very limited natural reproduction occurring in the CSMA for several decades (Hawkins 1979; Judy and Hawkins 1982; NCDMF 2005; Barwick et al. 2008; NCDMF 2013; Darsee et al. 2019). The existence of limited natural reproduction in the CSMA is supported by results of otolith microchemistry work suggesting 53% of striped bass sampled in the Neuse River in 2010 were not of hatchery origin (Rulifson 2014).

1.2.4.4 **Maturation & Fecundity**

There is a strong positive correlation between the length, weight, and age of a female striped bass and the number of eggs produced (Monteleone and Houde 1990; Olsen and Rulifson 1992; Boyd 2011; Knight 2015).

In the Tar-Pamlico and Neuse rivers, 50% of female striped bass are mature at 2.7 years and 98% are mature by age-3 (Knight 2015). Length at 50% maturity (L50) in the CSMA was estimated at 467.8 mm TL (18.4 inches TL) and fish were estimated to be 100% mature at 537.3 mm TL (21.1 inches TL). Female striped bass produce large quantities of eggs which are broadcast into riverine spawning areas and fertilized by mature males, typically age-2 and older. In the Tar-Pamlico and Neuse rivers, fecundity ranged from 223,110 eggs for an age-3 female to 3,273,206 eggs for an age 10 female.

1.2.5 Mortality

A telemetry tagging study on the Neuse River estimated a discrete annual total mortality of 66.3% for phase II stocked juveniles (202–227 mm TL), a discrete annual total mortality of 54.0% for adults (349–923 mm TL), and a discrete natural mortality of 20.1% for adults (Bradley et al. 2018b). A tagging study showed that striped bass stocked in the Neuse and Tar-Pamlico rivers experienced higher mortality (instantaneous total mortality of 0.48–0.51) than in their natal habitat (instantaneous total mortality of 0.33; Callihan et al. 2014).

Instantaneous total mortality of striped bass in the Neuse River varied considerably from 1997–2011, ranging from 0.36 to 1.08 (Rachels and Ricks 2018). Mortality was generally lowest during the period 1997–2007 and highest during the period 2008–2011. Instantaneous fishing mortality ranged from 0.12–0.84 assuming the instantaneous natural mortality rate given by Bradley (2016) remained constant throughout the time series.

1.2.6 Food & Feeding Habits

Striped bass are opportunistic feeders; specific food types depend upon the size of the fish, habitat, and the season (Rulifson et al. 1982b). Striped bass undergo an ontogenetic shift in diet with larvae feeding primarily on mobile planktonic invertebrates (Doroshev 1970; Markle and Grant 1970; Bason 1971). As they grow, juvenile striped bass diets include larger aquatic invertebrates and small fish (Shapovalov 1936; Ware 1971). Adult striped bass are piscivorous and primarily feed on fish in the Family Clupeidae, including Atlantic menhaden (*Brevoortia tyrannus*), alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), and gizzard shad (*Dorosoma cepedianum*; Manooch 1973).

Binion-Rock (2018) conducted a multispecies food habits study for 25 finfish species in Pamlico Sound, North Carolina and its tributaries and found that Atlantic menhaden, spot (*Leiostomus* *xanthurus*), and Atlantic croaker (*Micropogonias undulatus*) were the most commonly consumed fish for larger predators, such as striped bass. Atlantic menhaden contributed the most to bluefish (*Pomatomus saltatrix*), longnose gar (*Lepisosteus osseus*), spotted seatrout (*Cynoscion nebulosus*), and striped bass diets. Striped bass diets also consisted of forage species including anchovies, silversides, mollusks, and polychaetes. Striped bass were also reported as prey items consumed by bluefish, longnose gar, and spotted seatrout.

1.3 Habitat

Striped bass use a variety of habitats with variations in preference due to location, season, and ontogenetic stage. Although primarily estuarine, striped bass use habitats throughout the estuaries and the coastal ocean. Striped bass are found in most habitats identified by the North Carolina Coastal Habitat Protection Plan (CHPP) including water column, wetlands, submerged aquatic vegetation (SAV), soft bottom, hard bottom, and shell bottom (NCDEQ 2016).

The loss of habitat has contributed to the decline in anadromous fish stocks throughout the world (Limburg and Waldman 2009). Numerous documents have been devoted entirely to habitat issues and concerns, including the North Carolina Coastal Habitat Improvement Plan (Street et al. 2005) and ASMFC's "Atlantic Coast Diadromous Fish Habitat: A review of Utilization, Threats, Recommendations for Conservation, and Research Needs" (Greene et al. 2009).

1.3.1 Spawning Habitat

Spawning grounds are not clearly defined in CSMA systems as access to spawning areas is influenced by river flows as well as impediments to migration. In the Tar-Pamlico River, the main spawning habitat for striped bass occurs from the Rocky Mount Mills Dam downstream approximately 72 km to the vicinity of the town of Tarboro (Kornegay and Humphries 1975; Rock et al. 2018). Acoustic tagging data indicate spawning areas in the Tar-Pamlico River likely occur from the area around Dunbar Road downstream to Tarboro (Rock et al. 2018).

During NCWRC striped bass surveys on the Neuse River, spawning aggregates have been observed from Raleigh, North Carolina to Kinston, North Carolina and acoustic detection data indicate striped bass move upriver as far as Raleigh during the spawning season (Rock et al. 2018). During high flows fish are more likely to spawn near Raleigh, North Carolina (approximately river kilometer (rkm) 350), and when flows are lower fish tend to spawn further downstream around Smithfield, North Carolina (approximately rkm 300; Burdick and Hightower 2006). Striped bass spawning has also been observed further downriver near Goldsboro, North Carolina (rkm 240) and was correlated with higher water velocities and larger substrates (Beasley and Hightower 2000).

In a study conducted by the NCWRC in 2016 and 2017, Neuse River water velocities appeared to be sufficient to keep striped bass eggs suspended until hatching (Buckley et al. 2019). Although water velocities were more variable in 2017, mean velocity for all sites in both years was above the minimum water velocity (30 cm/s) recommended by Albrecht (1964). Additionally, Neuse River velocities were comparable to those observed in the Roanoke River (USGS Oak City, NC 02081022, USGS Williamston, NC 02081054, and Barnhill's Landing from Rulifson and Isely, 1995; Buckley et al., 2019). A study in the Roanoke River indicated that river flow during the pre-spawn and post-spawn periods was the most important factor contributing to survival of larval fish (Hassler 1981); however, comparisons between systems may not be appropriate because of differences in river depth.

In the Cape Fear River, historic anadromous fish spawning areas have been identified from below the mouth of Town Creek, North Carolina to upstream as far as Lillington, North Carolina (Sholar 1977). Three locks and dams were constructed on the main stem of the Cape Fear River between Riegelwood, North Carolina and Tar Heel, North Carolina and the lowermost was completed in 1915 and the uppermost in 1935. These impediments to passage limit the ability of striped bass to reach known historic spawning areas near Smiley Falls at the fall line in Lillington, North Carolina (Nichols and Louder 1970). Several studies in the Cape Fear River have tracked adult striped bass to show evidence of spawning and/or spawning migrations in the main stem river to and above the locks and dams (Ashley and Rachels 2006; Smith 2009; Smith and Hightower 2012). Rock et al. (2018) found that striped bass in the Cape Fear River were generally detected at a core region near downtown Wilmington during all seasons and that many striped bass in the Cape Fear system showed fidelity to and made repeated spring migrations each year up the Northeast and Cape Fear rivers, suggesting spawning migrations or behavioral contingents.

In the Northeast Cape Fear River, Winslow et al. (1983) documented striped bass spawning areas to be located from Croomsbridge Road (rkm 130) to Ness Creek (rkm 47) in the lower Northeast Cape Fear River, and stated that peak spawning occurred in the area downstream of Lanes Ferry (rkm 93); however, Rock et al. (2018) determined that during the spawning season, striped bass migrate to at least near Hallsville, North Carolina (rkm 183), and mature fish were captured between White Stocking, North Carolina (rkm 118) and Chinquapin, North Carolina (rkm 168), thus it is likely that the extent of the upriver spawning habitat in the Northeast Cape Fear River has been underestimated.

1.3.2 Nursery & Juvenile Habitat

Neuse River juvenile striped bass captured in 1979 appeared to show no preference for fresh or brackish water areas but were associated with sandy bottom areas near grass beds (Hawkins 1979).

1.3.3 Adult Habitat

In the Tar-Pamlico river, striped bass are able to migrate as far as Rocky Mount, North Carolina, where Rocky Mount Mills Dam prevents further upstream migration. In the Neuse River, Quaker Neck Dam was removed near Goldsboro, North Carolina in 1998 and Milburnie Dam, in Raleigh, North Carolina, was removed in 2017. Currently, striped bass can access habitats from Falls Dam at Raleigh, North Carolina downstream to the Pamlico Sound. Striped bass are primarily found in these upriver locations during the spawning season from March through May. During the summer and fall, striped bass in the Neuse River concentrate in an area from New Bern downstream to Slocum and Hancock Creeks, and in the Tar-Pamlico River striped bass concentrate in an area from Washington to South Creek (Rock et al. 2018). In the Cape Fear River, adult fish distribution is centered in the upper estuary at the confluence of Cape Fear and Northeast Cape Fear rivers (Wilmington, North Carolina; Stewart and Li 2019).

1.3.4 Habitat Issues & & Concerns

There are many contaminants known to adversely affect striped bass at various life stages, particularly at the egg and larvae stages (Setzler et al. 1980; see Richards and Rago 1999 for review), but little is known about current contaminants in the CSMA. Adequate river flows during the spawning season are also needed to keep eggs suspended for proper development (Manooch and Ru1ifson 1989). Hassler (1981) indicated that river flow during the pre-spawn and post-spawn periods was the most important factor contributing to survival of fish larvae.

Between 1915 and 1935, three locks and dams were constructed on the Cape Fear River. These structures inhibit access to the historical striped bass spawning grounds. A rock arch rapids fishway was constructed at Lock and Dam 1 in 2012 to provide improved volitional passage for anadromous fish; however, Raabe et al. (2019) determined the structure was not effective for striped bass. Consequently, striped bass reproduction is limited because migration to traditional spawning grounds on the Cape Fear River is restricted.

1.4 Description of Fisheries

1.4.1 Commercial Fishery

Commercial landings in the CSMA have been constrained by an annual Total Allowable Landings (TAL) of 25,000 pounds since 1994. Most commercial landings come from the Pamlico and Pungo rivers and the Neuse and Bay riversand the remainder come from Pamlico Sound. Since 2004, there has only been a spring harvest season, recently opening March 1 each year and closing when the TAL is reached. In 2008 due to continued concerns over low abundance levels, a no-harvest provision was implemented in the Cape Fear River. Due to the no possession measure for the remainder of the CSMA approved in Supplement A to Amendment 1 to the N.C. Estuarine Striped Bass FMP (NCDMF 2019a), the commercial striped bass fishery was closed in 2019 while Amendment 2 to the N.C. Striped Bass FMP is developed (refer to Figure 2.1).

1.4.2 Recreational Fishery

Coastal striped bass populations have continuously provided a popular and economically important recreational fishery in North Carolina. Despite past surveys covering a considerable area, recreational fisheries data were lacking for the CSMA when the stock was listed as overfished in 2003. A comprehensive creel survey was initiated in January 2004 to identify and estimate recreational striped bass effort and catch in the CSMA, particularly the Tar-Pamlico and Neuse river systems. Due to the recreational no possession measure implemented by the NCMFC and the NCWRC in Supplement A to Amendment 1 to the N.C. Estuarine Striped Bass FMP (NCDMF 2019a), the recreational striped bass fishery was closed in 2019 while Amendment 2 to the N.C. Striped Bass FMP is developed (refer to Figure 2.4).

1.5 Fisheries Management

1.5.1 Management Authority

Fisheries management includes all activities associated with maintenance, improvement, and utilization of the fisheries resources of the coastal area including research, development, regulation, enhancement, and enforcement. North Carolina's existing fisheries management system is powerful and flexible and rulemaking (and proclamation) authority is vested in the NCMFC and the NCWRC within their respective jurisdictions.

The North Carolina Department of Environmental Quality (NCDEQ) is the parent agency of the NCMFC and the NCDMF. The NCMFC is responsible for managing, protecting, preserving, and enhancing the marine and estuarine resources under its jurisdiction, which includes all state coastal fishing waters extending to three miles offshore. In support of these responsibilities, the NCDMF conducts management, enforcement, research, monitoring statistics, and licensing programs to provide information on which to base these decisions. The NCDMF presents information to the NCMFC and NCDEQ in the form of fisheries management and coastal habitat protections plans and proposed rules. The NCDMF also administers and enforces the NCMFC's adopted rules.

The NCWRC is a state government agency authorized by the General Assembly to conserve and sustain the state's fish and wildlife resources through research, scientific management, wise use, and public input. The NCWRC is the regulatory agency responsible for the creation and enforcement of hunting, trapping, and boating laws statewide and fishing laws within its jurisdictional boundaries including all designated inland fishing waters. The NCWRC and NCDMF share authority for regulating recreational fishing activity in joint fishing waters.

1.5.2 Management Unit Definition

There are three geographic management units defined in the Estuarine Striped Bass FMP and the fisheries throughout the coastal systems of North Carolina (NCDMF 2004). The management unit for this evaluation is the CSMA and is defined as:

The CSMA includes all internal coastal, joint and contiguous inland waters of North Carolina south of the ASMA to the South Carolina state line. There are spawning stocks in each of the major river systems within the CSMA; the Tar-Pamlico, the Neuse, and the Cape Fear. These stocks are collectively referred to as the CSMA stocks. Spawning grounds are not clearly defined in these systems as access to spawning areas is influenced by river flows as well as impediments to migration. Management of striped bass within the CSMA is the sole responsibility of the NCMFC and the NCWRC and is not subject to compliance with the ASMFC Interstate FMP for Atlantic Striped Bass (Figure 1.1).

1.5.3 Regulatory History

Estuarine striped bass in North Carolina are managed jointly by the NCMFC and the NCWRC under Amendment 1 (NCDMF 2013), Revision 1 to Amendment 1 (NCDMF 2014), and Supplement A to Amendment 1 (NCDMF 2019a) to the N.C. Estuarine Striped Bass FMP (NCDMF 2004). Amendment 1, adopted in 2013, lays out separate management strategies for the A-R stock in the ASMA and the RRMA and the CSMA stocks in the Tar-Pamlico, Neuse, and Cape Fear rivers. Management measures in Amendment 1 consist of daily possession limits, open and closed harvest seasons, seasonal gill-net attendance and other gill-net requirements, minimum size limits, and slot limits to maintain sustainable harvest and reduce regulatory discard mortality in all sectors. Amendment 1 also maintained the stocking measures in the major CSMA river systems and the harvest moratorium on striped bass in the Cape Fear River and its tributaries, including Snow's Cut (NCDMF 2013).

The following regulations were initially contained in the jointly adopted Amendment 1 to the N.C. Estuarine Striped Bass FMP. Both commercial and recreational fisheries are subject to an 18-inch TL minimum size limit for striped bass within the CSMA. As an additional protective measure in joint and inland CSMA waters, it is unlawful for recreational fishermen to possess striped bass between 22 and 27 inches TL. The recreational harvest season for striped bass within the CSMA is October 1 through April 30. Recreational fishermen are constrained to a two fish per person per day possession limit.

The striped bass commercial fishery in the CSMA is a directed fishery, except in Pamlico Sound where bycatch restrictions are in place and primarily uses anchored large mesh (≥5 inches stretched mesh (ISM) gill nets. There is a commercial daily possession limit of 10 fish per person per day with a maximum of two limits per commercial operation issued by proclamation. Daily reporting of the number and pounds of striped bass landed from all licensed striped bass dealers helps ensure the 25,000 pound total allowable landings (TAL) is not exceeded. The commercial harvest season opens by proclamation and may occur between January 1 and April 30 and is closed by proclamation once the annual 25,000 pound TAL is reached or on April 30, whichever occurs first. After closure of the commercial harvest season and continuing through December 31, commercial fishermen are required to use three-foot tie downs in gill nets with a stretch mesh length ≥5 inches in internal coastal fishing waters west of the 76 28.0000' W longitude line. They must also maintain a minimum distance from shore (DFS) of 50 yards for these nets upstream of the existing DFS line.

In recreational and commercial fisheries, it has been unlawful to possess striped bass taken from the internal coastal and joint waters of the Cape Fear River and its tributaries since 2008 per MFC Rules 15A NCAC 03M .0202 and 03Q .0107, and in the inland fishing waters of the Cape Fear River and its tributaries downstream of Buckhorn Dam per NCWRC rules 15A NCAC 10C .0314 (h).

The following management change was implemented solely under the purview of the NCWRC and was not developed through the NCDMF FMP process. The NCWRC has jurisdiction in the inland waters of the CSMA, and on February 16, 2016, the NCWRC voted to modify the exception to the general statewide size regulation for striped bass in inland waters of the Tar-Pamlico, Pungo, and Neuse rivers and their tributaries by increasing the minimum size limit from 18 inches to 26 inches TL. The no-possession prohibition on fish between 22 and 27 inches TL was removed. The daily creel limit (two fish per person per day) and harvest season (October 1–April 30) were not changed. The new rule was scheduled to go into effect August 1, 2017, but ten letters of objection requesting legislative review of the rule were received in March 2017. No action was taken during the mandatory legislative review period, and the rule 15A NCAC 10C .0314 became effective on June 1, 2018.

Supplement A to Amendment 1 to the N.C. Estuarine Striped Bass FMP was adopted by the NCMFC at their February 2019 business meeting and by the NCWRC in March 2019 (NCDMF 2019a). Supplement actions in the FMP implemented March 29, 2019 consisted of a recreational no possession measure for striped bass (including hybrids) in coastal and inland fishing waters of the CSMA (NCDMF Proclamation FF-6-2019). The NCWRC hook-and-line closure proclamation had the effect of suspending rules 15A NCAC 10C .0107 (l) and 10C .0314 (g). A no-possession requirement has been in place for the Cape Fear River by rule since 2008.

In March 2019, the NCMFC held an emergency meeting that directed the NCDMF to issue a proclamation regarding gill nets, beyond what was contained in Supplement A to Amendment 1 to the N.C. Estuarine Striped Bass FMP. Proclamation (M-6-2019) prohibits the use of all gill nets upstream of the ferry lines from the Bayview Ferry to Aurora Ferry on the Pamlico River and the Minnesott Beach Ferry to Cherry Branch Ferry on the Neuse River. It also maintains tie-down (vertical net height restrictions) and distance from shore restrictions for gill nets with a stretched mesh length 5 inches and greater in the western Pamlico Sound and rivers.

An emergency meeting called under North Carolina General Statute section 113-221.1(d), authorizes the NCMFC to review the desirability of directing the fisheries director to issue a proclamation. Once the NCMFC votes under this provision to direct issuance of a proclamation, the NCDMF fisheries director has no discretion to choose another management option and is bound by law to follow the NCMFC decision. In these cases, under existing law, the decision of the NCMFC to direct the director to issue a proclamation is final and can only be overruled by the courts.

1.5.4 Current Regulations

Commercial and recreational harvest of striped bass in the CSMA is prohibited. Supplement A to the N.C. Estuarine Striped Bass FMP was adopted by the NCMFC at their February 2019 business meeting (NCDMF Proclamation FF-6-2019) and by the NCWRC in March 2019. The NCWRC hook-and-line closure proclamation had the effect of suspending rules 15A NCAC 10C .0107 (l) and 10C .0314 (g). NCDMF proclamation (M-6-2019) prohibits the use of all gill nets upstream of the ferry lines from the Bayview Ferry to Aurora Ferry on the Pamlico River and the Minnesott Beach Ferry to Cherry Branch Ferry on the Neuse River. It also maintains tie-down (vertical net height restrictions) and distance from shore restrictions for gill nets with a stretched mesh length 5 inches and greater in the western Pamlico Sound and rivers.

As a response to low numbers of documented spawning adults and limited evidence of juvenile recruitment, the NCDMF and NCWRC implemented, by separate rule making, a moratorium on both the commercial and recreational harvest of striped bass in the Cape Fear River in 2008, which is still in effect.

1.5.5 Management Performance

Stocking appears to have maintained striped bass populations in the Tar-Pamlico and Neuse rivers during recent history, in the absence of stocking, population declines likely would have occurred given the absence of natural recruitment and evidence that populations remain almost entirely composed of hatchery fish. The slot limit imposed on the joint and inland waters portions of the Tar-Pamlico and Neuse rivers does not seem to have protected spawning females to older age classes as intended. In an effort to reduce discards in the commercial fishery, tie-downs and distance from shore measures adopted in the 2004 Estuarine Striped Bass FMP (NCDMF 2004) were implemented in 2008. Rock et al. (2016) investigated the effectiveness of these management measures by collecting effort, catch, and bycatch data for striped bass in the commercial estuarine large mesh gill-net fishery. Due to the persistence of striped bass in nearshore waters and the comparatively low number of discarded striped bass observed in commercial gill nets, it appears as though the distance from shore and tie-down requirements enacted in 2008 have been successful in reducing the number of striped bass discards in the commercial gill-net fishery in the Tar-Pamlico and Neuse rivers. Overall, this study indicated approximately an 82% reduction in striped bass discards from previous levels estimated in Amendment 1 to the Estuarine Striped Bass FMP (NCDMF 2014); however, Rachels and Ricks (2018) observed that gill-net effort (number of nets set annually) had greater impact on Neuse River striped bass mortality rates than commercial harvest and theorized that discard mortality continues to significantly impact the population. The work of Rachels and Ricks (2018) was expanded as part of this assessment to include removals from all sectors (recreational and commercial) that could influence discrete annual mortality. Results from additional analysis showed, along with the relative annual variation in commercial

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effort and in commercial harvest, the relative annual variation in recreational effort and in recreational discards were also significant factors contributing to the relative annual variation in total mortality of striped bass in the Neuse River (see section 5).

1.6 Assessment History

No formal peer-reviewed stock assessments have been conducted for the CSMA striped bass.

1.6.1 Review of Previous Methods & Results

No peer-reviewed stock assessments have been conducted for the CSMA striped bass; however, an index-based method of catch curve analysis was used to assess the status of striped bass populations in the CSMA (Appendix 14.7 in NCDMF 2013). The large confidence intervals and lack of precision in the catch curve Z estimates (total instantaneous mortality rate) made them unsuitable for making a stock status determination (NCDMF 2013).

1.6.2 Progress on Research Recommendations

No peer reviewed stock assessment has been conducted for CSMA striped bass stocks. However, many of the research recommendations from the FMP focused on collection of data and life history information needed for completion of a stock assessment.

- Increase surveys of stocked systems to determine percent contribution of hatchery stocked fish (ongoing through NCWRC and NCDMF genetics survey)
- Conduct egg abundance and egg viability studies

  The NCWRC and the NCDMF continue to collect genetic data throughout the range of striped bass to evaluate the percent contribution of hatchery stocked fish. In 2016 and 2017, the NCWRC sampled anadromous ichthyoplankton to investigate striped bass egg and larval abundance and egg viability (Buckley and Ricks 2018). In 2017, North Carolina State University began research designed to investigate striped bass egg yolk composition, egg buoyancy, and recruitment.

- Acquire life history information: maturity, fecundity, size and weight at age, egg and larval survival

  Knight (2015) conducted research on striped bass maturation and fecundity in the Neuse and Tar-Pamlico rivers and additional work is ongoing through the NCDMF ageing program. In 2017, to adequately capture all life stages of striped bass, Program 100 was expanded into the CSMA to evaluate juvenile striped bass recruitment.

- Improve tagging program, conduct a mark-recapture study utilizing conventional tags and telemetry approaches to estimate fishing mortality and abundance

  Conventional tagging and deployment of acoustic tagged striped bass has continued in the CSMA to improve estimates of fishing mortality and abundance. Rock et al. (2018) assessed critical habitat, movement patterns, and spawning grounds of anadromous fishes in the Tar-Pamlico, Neuse, and Cape Fear rivers using telemetry tagging techniques.

- Develop better estimates of life-history parameters, especially growth and natural mortality

In an effort to improve discard estimates in the commercial gill-net fishery, Rock et al. (2016) evaluated discard estimates through the NCDMF creel survey and an expanded NCDMF observer program. Bradley et al. (2018a and 2018b) conducted research in the Neuse River to estimate mortality rates of juvenile and adult striped bass, determine distribution and migration patterns of adults, and built an age-structured population model to explore the effects of observed mortality rates on the adult population.

2 DATA

2.1 Fisheries-Dependent

2.1.1 Commercial Landings

Prior to 1978, North Carolina's commercial landings data were collected by the National Marine Fisheries Service (NMFS). Between 1978 and 1993, landings information was gathered through the NMFS/North Carolina Cooperative Statistics program. Reporting was voluntary during this period and North Carolina and NMFS port agents sampled the state's major dealers (Lupton and Phalen 1996).

On January 1, 1994, the NCDMF initiated a Trip Ticket Program (TTP) to obtain more complete and accurate trip-level commercial landings statistics (Lupton and Phalen 1996). Trip ticket forms are used by state-licensed fish dealers to document all transfers of fish sold from coastal waters from the fishermen to the dealer. The data reported on these forms include transaction date, area fished, gear used, and landed species as well as fishermen and dealer information.

The majority of trips reported to the NCDMF TTP only record one gear per trip; however, as many as three gears can be reported on a trip ticket and are entered by the program's data clerks in no particular order. When multiple gears are listed on a trip ticket, the first gear may not be the gear used to catch a specific species if multiple species were listed on the same ticket but caught with different gears. In 2004, electronic reporting of trip tickets became available to commercial dealers and made it possible to associate a specific gear for each species reported. This increased the accuracy of reporting by documenting the correct relationship between gear and species.

2.1.1.1 **Sampling Intensity**

North Carolina dealers are required to record the transaction at the time of the transactions and report trip-level data to the NCDMF (see NCDMF 2019).

2.1.1.2 **Biological Sampling**

Historically, biological sampling occurred during the spring and fall fishery; however, since 2004 there has only been a spring harvest season. This is a directed fishery (except Pamlico Sound) for striped bass primarily using anchored gill nets. Commercial fish houses are sampled throughout the CSMA, during each open harvest season. Fish are measured to the nearest mm for fork length (FL) and TL and weighed to the nearest 0.01 kg. Striped bass scales and otoliths have been collected sporadically by the NCDMF since 1975, although since 2003 both scales and otoliths have been collected routinely. Scales are removed from the left side of the fish, above the lateral line and between the posterior of the first dorsal fin and the insertion of the second dorsal fin. Scales are cleaned and pressed on acetate sheets using a Carver heated hydraulic press. NCDMF staff read scales using a microfiche reader set on 24x or 33x magnification. Otoliths are collected from the left and right sides, but only one side (left) is typically sectioned and mounted for ageing. To prepare otoliths for ageing, thin sections of whole otoliths were cut, mounted to a slide, ground down, and covered with a top coat. Starting in 2016, although limited in number, PBT samples were also collected by taking a partial pelvic fin clip and preserving in 95% ethyl alcohol.

2.1.1.3 **Potential Biases & Uncertainties**

All fish that are caught are not required to be landed and sold so some fish may be taken for personal consumption and not reported in the landings under this program authority. Hadley (2015) found that 28% of commercial license holders maintained a license for personal consumption or donation of harvest. Another potential bias relates to the reporting of multiple gears on a single trip ticket because the order in which gears are reported is not indicative of the primary method of capture.

2.1.1.4 **Development of Estimates**

Commercial landings were summarized by year using the NCDMF TTP data. Length data collected from the commercial fish house sampling program were used to compute annual length-frequency distributions.

2.1.1.5 **Estimates of Commercial Landings Statistics**

Commercial landings in the CSMA have been constrained by an annual TAL of 25,000 pounds since 1994. Over the past ten years, landings have closely followed the annual TAL, except for 2008 when less than half of the TAL was landed. Since 2004, striped bass commercial landings in the CSMA have averaged 24,179 pounds and ranged from a low of 10,115 pounds in 2008 to a high of 32,479 pounds in 2004 (Figure 2.1). Most commercial landings come from the Pamlico and Pungo rivers and the Neuse and Bay rivers and the remainder come from the Pamlico Sound (Figure 2.2).

Length data from the commercial harvest shows that on average striped bass in the Neuse and Bay rivers are slightly larger than fish harvested in the Pamlico and Pungo rivers (Table 2.1). Additionally, maximum lengths are generally larger in the Neuse and Bay rivers compared to the Pamlico and Pungo rivers. CSMA commercial length frequencies show that striped bass are routinely harvested up to 30 inches total length and that few fish under the 18 inch total length minimum size limit are harvested (Figures 2.3, 2.4).

2.1.2 Commercial Gill-Net Discards

2.1.2.1 **Survey Design & Methods**

NCDMF's Program 466 (Onboard Observer Monitoring) was designed to monitor fisheries for protected species interactions in the gill-net fishery by providing onboard observations. Additionally, this program monitors finfish bycatch and characterizes effort in the fishery. The onboard observer program requires the observer to ride onboard the commercial fishermen's vessel and record detailed gill-net catch, bycatch, and discard information for all species encountered. Observers contact licensed commercial gill-net fishermen holding an Estuarine Gill-Net Permit (EGNP) throughout the state to coordinate observed fishing trips. Observers may also observe fishing trips from NCDMF vessels under Program 467 (Alternative Platform Observer Program), but these data were not used in this analysis due to the lack of biological data collected through the program.

2.1.2.2 **Sampling Intensity**

Commercial fishing trips targeting striped bass are observed during the open season (March–April); however, most observed trips occur outside of that time period when striped bass are discarded as bycatch in other gill-net fisheries.

2.1.2.3 **Biological Sampling**

Data recorded includes species, weight, length, and fate (landed, live discard, or dead discard).

2.1.2.4 **Potential Biases & Uncertainties**

Program 466 began sampling statewide in May 2010. To provide optimal coverage throughout the state, management units were created to maintain proper coverage of the fisheries. Management units were delineated based on four primary factors: (1) similarity of fisheries and management, (2) extent of known protected species interactions in commercial gill-net fisheries, (3) unit size, and (4) the ability of the NCDMF to monitor fishing effort. Total effort for each management unit can vary annually based on fishery closures due to protected species interactions or other regulatory actions. Therefore, the number of trips and effort sampled each year by management unit varies both spatially and temporally.

Program 466 data do not span the entire time series for this analysis (no data are available for 1991–2000) and statewide sampling began in May 2010 decreasing the variability of observed trips with better spatial and temporal sampling beginning in 2012.

Striped bass discard data were not available in sufficient quantities to estimate discards or post-release mortality from other fisheries; however, other gears, like pound nets, are known to have discards of striped bass.

It is also important to note that this survey was designed to target trips that occur in times and areas where protected species interactions are highest; the program does not target striped bass trips. For this reason, a high number of zero-catch trips relative to striped bass occur in the data.

2.1.2.5 **Development of Estimates**

A generalized linear model (GLM) framework was used to estimate striped bass discards in the North Carolina commercial gill-net fishery based on data collected from the mandatory observer program (initiated 2012) during 2013 through 2018. The presence or absence of striped bass from on-board observer trips in the Tar-Pamlico and Neuse rivers (Figure 2.5) was used to more accurately estimate striped bass discards from the commercial gill-net fisheries (Figure 2.6). Only those variables available in all data sources were considered as potential covariates in the model. Available variables were year, season, mesh category (small: <5 inches and large: ≥5 inches), and area (Figure 2.6), which were all treated as categorical variables in the model. Year is based on the calendar year. Season is based on the calendar year such that January through February, and December equates to winter, March through May equates to spring, June through August equates to summer, and September through November equates to fall. Discards were assigned to one of four areas: (1) Albemarle-Roanoke, (2) Neuse, (3) Tar-Pamlico, or (4) Cape Fear. Though estimates for the Albemarle-Roanoke were produced, they are not presented in this report. Due to the overall low gill-net activity and observed striped bass in the Cape Fear River during the 2013 to 2018-time period, commercial discards could not be estimated for this area.

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All available covariates were included in the initial model and assessed for significance using likelihood ratio tests (Zuur 2012). Non-significant covariates were removed using backwards selection to find the best-fitting predictive model. An offset term was included in the model to account for differences in fishing effort among observations (Zuur et al. 2009, 2012). Effort was measured as soak time (days) multiplied by net length (yards). Using effort as an offset term in the model assumes the number of striped bass discards is proportional to fishing effort (A. Zuur, Highland Statistics Ltd., personal communication).

Live and dead discards were modeled separately. Examination of the data indicated both the live and dead discard data were zero inflated. There are two types of models commonly used for count data that contain excess zeros. Those models are zero-altered (two-part or hurdle models) and zero-inflated (mixture) models (see Minami et al. 2007 and Zuur et al. 2009 for detailed information regarding the differences of these models). Minami et al. (2007) suggests that zero-inflated models may be more appropriate for catches of rarely encountered species; therefore, zero-inflated models were initially considered though were unable to converge. For this reason, zero-altered models were pursued.

The best-fitting models for live discards and for dead discards were applied to available effort data from the NCDMF TTP to estimate the total number of live discards and dead discards for the North Carolina commercial gill-net fishery. Because not all live discards survive, an estimate of post-release mortality was applied to the predicted number of live discards to estimate the number of live discards that did not survive. Live discards are multiplied by an estimated discard mortality rate for gill nets of 43% (ASMFC 2007). This estimate was added to the number of dead discards to produce an estimate of the total number of dead discards for the North Carolina commercial gill-net fishery.

2.1.2.6 **Estimates of Commercial Gill-Net Discard Statistics**

The best-fitting GLM for the commercial gill-net live discards assumed a zero-altered Poisson distribution (dispersion=3.3). The significant covariates for the count part of the model were year and mesh category and the significant covariates for the binomial part of the model were year, season, mesh category, and management area. The best-fitting GLM for the dead discards assumed a zero-altered Poisson distribution as well (dispersion=2.5). The significant covariates for the count part of the model were year, and season, and the significant covariate for the binomial part of the model was season.

In both the Neuse and Tar-Pamlico rivers, dead discards were higher in large mesh (≥5 inches) gill nets than in small mesh (<5 inches) gill nets, though in some years estimates between the two years were similar. Estimates of total dead discards in the Neuse River ranged from a low of 140 striped bass in 2017 to a high of 342 in 2013 (Table 2.2). Estimates of total dead discards in the Tar-Pamlico River were higher than in the Neuse River and ranged from a low of 306 striped bass in 2017 to a high of 709 in 2013 (Table 2.3). Relatively low estimates of dead discards are potentially an indicator that the distance from shore and tie-down requirements enacted in 2008 have been successful in reducing the number of striped bass discards in the commercial gill net fishery in the Tar-Pamlico and Neuse rivers (Rock et al. 2016).

2.1.3 Recreational Fishery Monitoring

A comprehensive angler creel survey was initiated in January 2004 to identify and estimate recreational striped bass effort and catch in the CSMA.

2.1.3.1 **Survey Design & Methods**

Survey points in the Neuse River 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 and 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 and all sites above Contentnea Creek considered the upper.

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, North Carolina. This system was divided into upper and lower zones and sites upstream of Greenville, North Carolina are 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.

2.1.3.2 **Sampling Intensity**

Recreational fishing statistics from the CSMA are calculated through a non-uniform stratified access-point creel survey (Pollock et al. 1994) on the Neuse, Pamlico, and Pungo rivers from January–December. Site probabilities were set in proportion to the likely use of the site according to time of day, day of the week, and season. Probabilities for this survey were assigned based on observed effort from past years and direct observation by creel clerks. Morning and afternoon periods were assigned unequal probabilities of conducting interviews and each period represents half a fishing day. A fishing day was defined as the period from one hour after sunrise until one hour after sunset. This is slightly different than in years prior to 2012 when the fishing day was defined as beginning 1.5 hours after sunrise. Monthly sampling periods for each river and zone were stratified accordingly, and all weekend and holiday dates along with two randomly selected weekdays were chosen from each week for sampling.

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

Returning fishing parties are 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.

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.

2.1.3.3 **Biological Sampling**

Harvested fish are 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. Scale collections were taken from available fish to determine age of catch. Since 2015, additional biological sampling has included the collection of striped bass fin clips for genetic analysis.

2.1.3.4 **Potential Biases & Uncertainties**

The current dockside sampling methodology only intercepts those individuals accessing inland, joint, and coastal waters via public boating access sites thereby excluding those individuals using private access such as residences, marinas, and community boat ramps. Given the substantial human footprint within the CSMA, it is certain that estimates of effort and catch currently being produced by the NCDMF are under-representative of the actual fishing pressure and associated catch occurring in these systems.

2.1.3.5 **Development of Estimates**

Effort and Catch Estimations

Only striped bass effort and catch data were used to produce estimates. 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 multiplied by access area probability). Total catch estimates for the CSMA and catch estimates for each zone and type of day were calculated based on the Horvitz-Thompson estimator for non-uniform probability sampling (NCDMF 2019b; Pollock et al. 1994). Total effort, in number of trips, over the CSMA and each individual zone and type of day were estimated in the same fashion, as were other extrapolated data. Targeted trips refer to trips where the angler explicitly identified their target species during the sampling interview. If multiple species were targeted, then a primary target species was designated (1st target; see Appendix IV.1 in NCDMF 2017). Approximate standard errors (SE) of the catch and effort estimates within zone and type of day were calculated based on the variance of the observations, the number of days sampled, and the number of days of that type available for sampling (Pollock et al. 1994). Percent standard errors (PSE) for the year are presented by river system and zone. Monthly PSEs within river system and zone are available upon request. Estimated catch-per-unit-effort (CPUE) values were obtained by dividing estimated catch by estimated striped bass trips as well as angler hours (angler-h) in order to identify trends in fishing pressure and angler success. Size structure of striped bass in harvests was described for each zone using length-frequency distributions of observed samples. Fishing party characteristics and methods used during striped bass trips reported by anglers were documented by river and day type. 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. Please note that estimates of catch and effort are expanded averages presented as whole numbers. Any inconsistency in the total catch and/or effort due to adding across rows or columns presented in this chapter is due to rounding.

2.1.3.6 **Estimates of Recreational Fishery Statistics**

In 2018, recreational landings were 10,844 pounds; however, recreational landings have fluctuated since 2004 and have ranged from lows in 2008 and 2009 to a high of 26,973 pounds most recently in 2017 (Table 2.4). In recent years, both the number of trips and the hours spent targeting striped bass within the CSMA have increased, although recreational harvest dropped sharply by more than half of the 2016 and 2017 values in 2018 (Table 2.4; Figure 2.7). Harvest on the Pungo River has remained consistent at a relatively low level compared to fluctuations in the Tar-Pamlico and Neuse rivers. Since 2011, harvest in the Tar-Pamlico and Neuse rivers has been similar, ranging from 4,000 pounds to 9,000 pounds; however, in 2016 and 2017 there was a sharp increase in recreational harvest (25,260 and 26,973 pounds, respectively; Figure 2.8).

Legal-sized striped bass discards have increased over the past six years, more than doubling in 2017 but returning to more normal levels in 2018 (12,232 legal sized discarded fish; Table 2.4). Fish released that were within the slot limit, have fluctuated since 2004 and have ranged from a low in 2004, 2006, and 2007 of zero fish to a high of 6,779 fish in 2016. In 2018, there were approximately 1,890 discarded striped bass that were within the slot limit. In 2017, mainly due to the large number of undersized striped bass available, there was more than a fivefold increase in the number of discards occurring in the fishery since 2015; however, in 2018 there was a sizeable decline back to more normal levels (34,128 under sized discarded fish; Table 2.4; Figure 2.9). Within the CSMA, there is a significant catch-and-release fishery during the summer in the middle reaches of the Tar-Pamlico and Neuse rivers. Releases during the last ten years have averaged 43,255 fish per year (Table 2.4). CSMA recreational length frequencies show that striped bass are routinely harvested up to 25 inches TL and that few fish under the 18 inch total length minimum size limit are harvested (Figures 2.10, 2.11).

2.2 Fisheries-Independent

2.2.1 Juvenile Abundance Survey (Program 100)

2.2.1.1 **Survey Design & Methods**

In 2017, exploratory juvenile abundance sampling was initiated in the Tar-Pamlico, Neuse, and Cape Fear rivers using trawl and seine nets replicating methods used in the ASMA. The fixed station survey uses an 18-foot semi-balloon trawl with a body mesh size of 0.75-inch and a 0.25-inch mesh tail bag with ten-minute tow times. Beach seines are 60-ft long by 6-ft tall, with a 6 ft by 6 ft by 6 ft bag constructed of 0.25-inch stretch mesh (ISM) in the body and 0.125 ISM in the bag. Seine nets are stretched parallel to shore approximately 30 feet from shore and pulled directly to the beach. NCDMF staff continue to develop and refine these abundance surveys in order to standardize sampling methods and locations. In the Tar-Pamlico River, sampling occurs from Washington, North Carolina to South Creek and in the Neuse River sampling occurs from New Bern to Slocum Creek (Figure 2.12). In the Cape Fear River, sampling occurs in the mainstem as well as in the Northeast Cape Fear, and between Lock and Dams 1 and 2 (Figure 2.13).

2.2.1.2 **Sampling Intensity**

Sampling in the Tar-Pamlico and Neuse rivers occurs during early June and continues through late October. Beach seines are conducted weekly at six locations in the Tar-Pamlico River and at six locations in the Neuse River. Sampling using seines starts the first week of June and continues weekly until the second week of July, for a total of six rounds of sampling and 72 total combined

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samples. Bi-weekly trawl samples are conducted at six locations in the Tar-Pamlico and at six locations in the Neuse River with ten-minute tow times. Sampling occurs from the third week of July through late October, for a total of eight rounds of sampling and 96 total combined samples.

Sampling in the Cape Fear River occurs during early June and continues through late October. Beach seines are conducted weekly from June through mid-July. Due to the hydrological features of the Cape Fear and tidal nature of the system, distance from shore is at maximum 30 feet. Several sites are unable to be sampled occasionally due to environmental conditions (i.e., high flow/flood conditions, low tide line at the drop-off to 60 feet).

Bi-weekly trawl samples are conducted at fixed locations in the Cape Fear River with ten-minute tow times starting the third week of July and ending in late October.

2.2.1.3 **Biological Sampling**

All striped bass captured are counted and a subsample (maximum of 30) is measured (mm; FL and TL). Genetic samples (fin clips) are collected from all juvenile striped bass captured in the CSMA surveys.

Surface and bottom water temperature (°C), dissolved oxygen (mg/L), secchi depth (cm), and salinity (ppt) are recorded at each station. Submerged aquatic vegetation (SAV) is identified to species and/or genus level.

2.2.1.4 **Potential Biases & Uncertainties**

The Juvenile Abundance Survey employs a fixed-station survey design that is currently exploratory in nature. A fixed-station survey can run the risk of bias if the sites selected do not adequately represent the sampling frame. Additionally, even if the sites adequately cover the sampling frame, the increased variation that would come about from sampling randomly is not accounted for and is therefore at risk of being neglected.

Indices derived from fixed-station surveys such as P100 may not accurately reflect changes in population abundance (Warren 1994, 1995); however, Blanchard et al. (2008) found that fixed-stratified survey design provided the greatest power to identify abundance trends in depleted stocks compared to random or random stratified. The accuracy of the estimates is tied to the degree of spatial persistence in catch data of the species (Lee and Rock 2018). The persistence of the P100 data in the CSMA has not been evaluated.

2.2.1.5 **Development of Estimates**

Because of the exploratory nature of the survey and the short time series and low catches, estimates of juvenile striped bass abundance cannot be developed at this time.

2.2.1.6 **Estimates of Survey Statistics**

In three years of sampling, no juvenile striped bass have been captured in the Tar-Pamlico or Neuse rivers. In the Cape Fear River (Northeast Cape Fear River), a total of 24 young-of-year (YOY) striped bass were captured in 2018 and four were captured in 2019. The YOY striped bass surveys in the CSMA were implemented to have sampling programs in place to monitor natural recruitment in these systems and measure the success of management strategies developed in Amendment 2 to the Striped Bass Fishery Management Plan. If natural recruitment does occur in the CSMA river systems, data from this survey will be valuable for estimating year-class strength and as an index of juvenile abundance in stock assessment models.

2.2.2 Independent Gill-Net Survey (Program 915)

The Fisheries-Independent Gill-Net Survey, also known as Program 915 (P915), employs a random survey design stratified by area and depth that has sampled in Hyde and Dare counties (Pamlico Sound) since 2001 and in the Tar-Pamlico, Pungo, and Neuse rivers since 2003. Sampling in the Cape Fear and New rivers was added in 2008, and sampling in the Central Region (Bogue Sound, Core Sound, White Oak River, etc.) has occurred since 2018.

The goal of the survey is to maintain long-term fisheries-independent surveys that will provide data on catch composition, relative abundance, size, and age for key species taken in the survey. The survey occurs over much of the habitat commonly utilized by striped bass and is used to calculate annual indices of abundance in major North Carolina estuaries for key estuarine species including striped bass.

2.2.2.1 **Survey Design & Methods**

The Independent Gill-Net Survey employs a stratified-random sampling design based on area and water depth for each region. Sampling in the Pamlico Sound is divided into two regions: Region 1 includes areas of eastern Pamlico Sound adjacent to the Outer Banks from southern Roanoke Island to the northern end of Portsmouth Island; Region 2 includes Hyde County bays from Stumpy Point Bay to Abel's Bay and adjacent areas of western Pamlico Sound (Figure 2.14). After grid delineation, each region is further segregated into four similar sized areas to ensure that samples are evenly distributed throughout each region.

Sampling in CSMA rivers is divided into three regions: the Pamlico Region includes areas of the Pamlico River from Washington, North Carolina to the mouth of the Pamlico River (south of Wade Point) and the Pungo River from Haystack Point and west to Belhaven and south to Jordan Creek; and the Neuse River from New Bern to Oriental, North Carolina (from Old House Point south to Sandy Point; Figure 2.15). The Central Region includes coastal waters from West Bay to the White Oak River, including parts of Core and Bogue Sounds (Figure 2.16). The area that includes the North River, Back Sound, southern Core Sound, lower portions of Jarrett Bay, and Barden Inlet (estuarine gill net management unit D-1) were removed from the study area to mitigate concerns over interactions with endangered sea turtles; and the Southern Region includes the New and Cape Fear rivers (Figure 2.17).

Each region is overlaid with a one-minute by one-minute grid system (equivalent to one square nautical mile) and delineated into shallow (<6 ft) and deep (>6 ft) strata using bathymetric data from NOAA navigational charts and field observations. NCDMF staff also considered factors such as obstructions to fishing, safety, and accessibility when evaluating each grid for inclusion in the sampling universe. After grid delineation, the Pamlico Sound and Pamlico/Pungo and Neuse rivers (Pamlico Region) are each segregated into four similar size areas to ensure samples are evenly distributed throughout each region. In the Pamlico/Pungo rivers, areas are assigned as follows: upper Pamlico (Washington, North Carolina to Ragged Point), middle Pamlico (Ragged Point to Gum Point), lower Pamlico (Gum Point to Wades Point), and Pungo (Haystack Point south to Sandy Point). In the Neuse River, areas are assigned as follows: upper Neuse (New Bern to Bay Point), upper-middle Neuse (Bay Point to Kennel Beach), lower-middle Neuse (Kennel Beach to Wilkinson Point), and lower Neuse (Wilkinson Point to Gum Thicket Shoal; Figure 2.15).

The Central region is divided into four areas of roughly equal geographic size (Figure 2.16). Area 1 includes West, Long, Cedar Island, and West Thorofare bays, as well as the northernmost part of Core Sound. Area 2 includes Core Sound and all adjoining waters south of area 1 to a line running west from the Clubhouse in Core Sound through the northernmost section of Jarrett Bay. This is the same line that separates the D-1 and B estuarine gill net management areas. Area 3 includes Newport River and adjoining waters, and eastern Bogue Sound to its midpoint. Area 4 includes western Bogue Sound and the White Oak River. The Central Region utilizes only shallow water sets due to depth limitations.

In the Southern region areas are assigned as follows: upper New (from Wilson Bay to Hines Point line extending eastward to French's Creek), lower New (Hines Point to the intersection of the New River and the Intracoastal Waterway), and the Cape Fear River is considered one area (the northern end of US Army Corps of Engineer's Island 13 south to the mouth of the river; Figure 2.17).

SAS/STAT® software procedure PLAN is used to select random sampling grids within each area (SAS Institute 2004). Sampling gear for the Pamlico, Central, and Southern regions consists of an array of gill nets (30-yard segments of 3, 3½, 4, 4½, 5, 5½, 6, and 6½-ISM webbing, 240 yards of gill net per sample). Catches from this array of gill nets comprised a single sample, while two samples (one shallow, one deep), totaling 480 yards of gill net fished, are completed in a sampling trip. In the Cape Fear River and Central Region, only shallow water samples are completed. If adverse weather conditions or other factors prevented the primary grid in an area from being sampled, alternative grids for that area are randomly selected to increase flexibility and ensure completion of sampling requirements each month.

Nets are deployed parallel or perpendicular to shore based on the strata and common fishing techniques for each area. Gear is deployed within an hour of sunset from February 15 to April 30 and September 1 to December 30 and within an hour and a half of sunset from May 1 to August 31. Gear is fished the following morning to keep soak times at a standard 12 hours. In the Southern Region, soak times are reduced to four hours from April 1 through September 30 and deployed within two hours of sunset and fished in the dark (sampling was modified in July 2008). This action was taken to minimize interactions with endangered and threatened sea turtles. Twine size is based on the twine size most frequently used by local commercial fishermen in the corresponding region (Pamlico, Central, and Southern: #177 or 0.47mm). All gill nets are constructed with a hanging ratio of 2:1. Nets constructed for shallow strata have a vertical height between six and seven feet. All deep water nets are constructed with a vertical height between ten and eleven feet. With this configuration, all gill nets fished the entire water column.

Physical and environmental conditions including surface and bottom water temperature (ºC), salinity (ppt), dissolved oxygen (mg/L), bottom composition, and a qualitative assessment of sediment size are recorded upon retrieval of the nets on each sampling trip. Reported water temperature, salinity, and dissolved oxygen values are the mean of surface and bottom values at deployment and retrieval of nets. All attached submerged aquatic vegetation (SAV) in the immediate sample area was identified to species and density of coverage is estimated visually when possible. Additional habitat data recorded include distance from shore, presence/absence of sea grass or shell, and substrate type.

Each sampling area within each region is sampled twice a month. For the Pamlico/Pungo and Neuse rivers, a total of 32 samples are completed (eight areas x twice a month x two samples; shallow and deep) each full month. For the Southern Region, a total of 12 samples are completed (New River: two areas x twice a month x two samples; Cape Fear River: one area x four times a month x one shallow sample) each month. Samples are collected from February 15 through December 15 each year. The period of December 16 through February 14 is not sampled due to low catch rates and safety concerns associated with fewer daylight hours and cold water and air temperatures during this period.

2.2.2.3 **Biological Sampling**

Each collection of fish (30-yard net) is sorted into individual species groups. All species groups are enumerated and an aggregate weight (nearest 0.01 kilogram, kg) is obtained for most species. Individuals are measured to the nearest millimeter FL or TL according to morphology of the species. Selected species, such as striped bass, are retained and taken to the lab where data on weight, lengths (FL and TL), age structures (otoliths, scales, and/or fin clips), sex, and maturity stage are collected.

2.2.2.4 **Potential Biases & Uncertainties**

Although this program was not designed to specifically target striped bass, striped bass occur in large enough numbers to make this survey a valuable data source to help manage this species. Though this survey does not sample the many shallow creeks and tributaries off the main river stems, habitats frequently used by striped bass, the stratified random design of the survey, and the broad area of habitats sampled in the main estuarine system should be sufficient to detect trends in striped bass relative abundance. The range of gill-net mesh sizes used in this survey would exclude the availability of the smallest and largest individuals to the sample gear.

Many factors affect gill-net catch efficiency including net visibility and turbidity (Berst 1961; Hansson and Rudstam 1995), though setting nets overnight may offset some concerns of net visibility. Efficiency can also decrease if nets become tangled or fouled with debris. In Program 915, performance of individual net panels is evaluated and recorded and catch is evaluated at the sample level (catch from a gang of nets is a sample), so performance of individual net panels may not have a large impact on catch from a sample.

2.2.2.5 **Development of Estimates**

The relative index is defined as the number of striped bass captured per sample (240 yards of gill net). P915 index precision appears to be good for most strata, months, and years, with some exceptions (Southern Region). The deep strata do not track well with the shallow strata after 2011 (Pamlico Region) and prior to 2005 (Pamlico Sound). Overall, the percent frequency of occurrence is lower and PSE values are typically higher in the deep stratum; thus, the deep stratum was dropped from index calculations. The months of April and October to November are used in index calculation because striped bass are most available to the survey during these months. The Pamlico Sound data were not used due to low catch numbers and concerns about stock assignment. Pungo River data were also excluded due to mixed stock concerns. Central Region data were not used due to the very short time series. In the Southern Region, although striped bass catch rates were very low, data from the Cape Fear River data were used to calculate an index. New River data were not used in index calculations because striped bass were seldom captured there.

2.2.2.6 **Estimates of Survey Statistics**

Samples collected from P915 on the Pamlico, Pungo, and Neuse rivers show most striped bass were captured in the upper and middle portions of the rivers. Over the past twelve years, striped bass indices show relative abundance has been higher in the Pamlico/Pungo and Neuse rivers when compared to the Cape Fear River (Table 2.5; Figure 2.18–2.20). Since 2004, striped bass relative abundance in the Pamlico/Pungo and Neuse rivers ranged from 0.84 to 2.66 fish per sample, whereas relative abundance in the Cape Fear River ranged from 0 to 0.14 fish per sample (Table 2.5). Length frequencies from P915 are represented in Figures 2.21 and 2.22. Length frequency distributions generally follow a normal bell-shaped patterns; however, in 2016 and 2017 in the Pamlico/Pungo and 2015–2017 in the Neuse rivers, there was a higher percentage of small fish that could represent the two year classes of striped bass thought to be the result of successful natural reproduction in 2014 and 2015. Due to a commercial and recreational no possession measure implemented in March 2019, fishery-independent programs like P915 will be the only source CSMA striped bass data while Amendment 2 to the N.C. Estuarine Striped Bass Fishery Management Plan is being developed and adopted.

2.2.3 Electrofishing Surveys

2.2.3.1 **Survey Design & Methods**

The objectives of the NCWRC spawning ground surveys are to monitor and quantify population metrics of striped bass migrating to the spawning grounds during spring of each year. Sampling in all rivers normally begins in March and continues into May when water temperatures consistently exceed optimal temperatures for spawning (18–22ºC) and striped bass spawning appears complete. The NCWRC uses a boat mounted electrofishing unit (Smith-Root 7.5 GPP; 5000–7000 W; 120 Hz) and either one or two dip netters to collect striped bass as they are observed. To minimize size selection during sampling, striped bass are netted as they are encountered regardless of size. Electrofishing time (seconds) is recorded for each sample site, and relative abundance of striped bass for each sample is indexed by the number of fish caught per hour (fish/h). Water temperature (°C) and other water quality measurements are recorded at each sample site.

In the Tar-Pamlico River, the electrofishing on the spawning grounds began in 1996. The survey uses a stratified random design, although the sampling design was less rigid in early years of the time series. The sample area extends from Battle Park in Rocky Mount to Tarboro, North Carolina and is divided into three approximately 20 km strata (Tar 1 Battle Park = Battle Park to Dunbar; Tar 2 Dunbar = Dunbar to Bell's Bridge; Tar 3 Bell's Bridge = Bell's Bridge to Tarboro town ramp; Figure 2.23). Weekly sampling events consist of boat electrofishing for approximately 1,800 seconds followed by maneuvering downstream several kilometers and sampling again for another 1,800 seconds within a stratum. The starting location of each sample site is randomly chosen within a stratum on a sample day. Sampling within each stratum is attempted each week, but low flow conditions can prohibit sampling in the upper stratum and flood conditions can prevent sampling all strata.

In the Neuse River, striped bass electrofishing surveys began in 1994. Sampling design has varied throughout the time series, but the survey has typically employed a stratified random design.

During some years, opportunistic sample sites were added if catches were low at random sites. Four strata were developed based on observation of striped bass spawning activity near Kinston, Goldsboro, Smithfield, and Raleigh, North Carolina (Figure 2.24). Only the Kinston and Goldsboro strata were sampled from 1994–1997, but Smithfield and Raleigh strata were added after removal of Quaker Neck Dam in 1998. Additionally, the Kinston stratum was only sampled after 1998 during drought conditions. The two primary sampling strata are located near Goldsboro, North Carolina, which is attempted weekly, but ability to sample the Smithfield, North Carolina and Raleigh, North Carolina strata is highly dependent upon accessibility due to low streamflow. Sample sites approximately 1 km in length are randomly selected within strata in most years; however, longer sites were sampled once per week in 2005, 2008, and 2014.

The Cape Fear River striped bass electrofishing survey was initiated in 2003. The survey is a fixed station design with four fixed sites: Buckhorn Dam (rkm 316) near Moncure, Lock and Dam 3 (rkm 186) near Tar Heel, Lock and Dam 2 (rkm 149) near Elizabethtown and Lock and Dam 1 (rkm 97) near Riegelwood (Figure 2.25). Fixed sites are sampled once weekly for 30 minutes of electrofishing time at each site. Sampling occurs immediately downstream of each dam with lock chambers sampled opportunistically during 2014–2016. Lock chamber sampling contributed little to striped bass catches. The number of sampling events per year ranged from eight to 43. Striped bass abundance during March sampling for American shad is typically low; therefore, March samples were excluded from analysis. The Buckhorn Dam site, added in 2014, was also excluded from final analyses because boating access is limited by low flows, the short time series is inconsistent with other sites, and catch rates are typically low at the site.

2.2.3.2 **Sampling Intensity**

In the Tar-Pamlico River, NCWRC personnel normally begin striped bass sampling in March and continue into May when water temperatures consistently exceed optimal temperatures for spawning (18–22ºC) and striped bass spawning appears complete.

NCWRC sampling on the Neuse River is conducted a minimum of once at each stratum per week during spawning season (dependent on adequate streamflow) and generally occurs April–May.

NCWRC personnel collect striped bass on the Cape Fear River weekly in April and May at each of three sample sites (Lock and Dam 1, Lock and Dam 2, Lock and Dam 3). Sampling continues through May until water temperatures exceed 22°C, or until a decline in CPUE signifies spawning completion. In 2009, sampling effort was standardized to approximately 30 minutes at each sample site. Sampling is typically not conducted when streamflow exceeds 20,000 cubic feet per second (cfs), which creates dangerous sampling conditions.

2.2.3.3 **Biological Sampling**

Individual striped bass are measured for TL (mm) and weighed (g). Sex is determined by applying directional pressure to the abdomen toward the vent and observing the presence of milt (male) or eggs (female). Typically, scales are removed from a subsample of fish in the field (target maximum of 15 fish for each sex and 25-mm size-class) on the left side of the fish between the lateral line and the dorsal fin. Before release, untagged striped bass are tagged with an individually numbered internal anchor tag as a cooperative effort with the NCWRC as part of the ongoing NCDMF Multi-Species Tagging Program. A partial pelvic fin clip is collected (approximately 200) and preserved in 95% ethyl alcohol to estimate contribution of hatchery fish to the spawning stock using

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parentage-based tagging. Striped bass scales are examined at 24X and 36X magnification using a microfiche reader, and annuli are counted to estimate age in accordance with standard protocols (NCWRC and NCDMF 2011). A subsample of 15 scales per 25-mm size-class per sex (as available) was aged by one reader, and a 20% verification subsample by size class was aged by a second reader. Differences between readers were resolved to establish 100% reader agreement. Subsample ages of the primary reader are compared to the secondary reader to determine ageing precision, and the entire sample is re-aged if bias patterns are detected.

2.2.3.4 **Potential Biases & Uncertainties**

Sample stations are often not accessible due to low river levels. This could bias the abundance estimates either by concentrating striped bass in the accessible areas or allowing striped bass to go undetected because of boating obstacles. Biases can also occur due to variation in river discharge; catch rates can be greatly influenced during high and low flows years by making fish less available. Additionally, it is possible that fish may be missed by the dip netter, or that using different numbers of dip netters could impact index calculations. If striped bass are not universally available to the dip netter at all population densities (full range of sizes and ages) during the spawning run, it could bias abundance estimates.

In the Tar-Pamlico River, an attempt is made to distribute sampling evenly among each of the sampling strata; yet, due to low river levels on some sampling days, the lower segment (closer to Tarboro) often receives a slightly greater proportion of the sampling effort. Spring streamflow and associated navigability significantly affect our ability to access spawning areas and may inflate or underestimate striped bass abundance within and among seasons. Analyses of relative abundance indices are further deterred by the lack of well-defined, concentrated spawning grounds such as those found on the Roanoke River.

In the Neuse River, striped bass catch rates can be influenced by streamflow conditions and obstructions to upstream migration. Quaker Neck Dam was removed in 1998, and sample sites further upstream were added thereafter. Upstream strata in Raleigh, North Carolina and Smithfield, North Carolina were added because striped bass had access to the upstream habitats after dam removal. In some years (e.g., 2005, 2008, 2014), entire strata were sampled rather than randomly selecting sites within the strata. Sampling upstream strata is highly dependent upon accessibility due to streamflow, with low flow conditions causing sampling to only occur in lower river strata. In these instances, striped bass potentially utilizing upper river habitats would not be sampled; however, striped bass access to upper river habitats is also limited during low water levels.

In the Cape Fear River, striped bass catch rates are influenced by abundance, habitat below each dam structure, and upstream passage rates through each lock and dam. Since the 1960s, the U.S. Army Corps of Engineers has operated the lock structures each spring for anadromous fish passage. In 2012, a rock arch rapids fishway was completed at Lock and Dam 1 and anadromous fish locking operations ceased at that location. It is likely that this operational change has influenced striped bass catch at each lock and dam due to habitat modification at Lock and Dam 1 and altered passage rates. The number of dip netters has varied (1 or 2) among and within years; however, the number of striped bass encountered on the Cape Fear River never approaches gear saturation with one dip netter; therefore, it is unlikely that catch rates are influenced by a second dip netter.

Other biases could be due to the gear itself. Striped bass of abnormal size may not be as vulnerable to the stunning effects of the electrofishing gear and could escape capture. Electrofishing tends to select for larger fish as they are more visible to the dip netters and have a lower immobilization threshold (Sullivan 1956; Reynolds 1996; Dolan and Miranda 2003; Ruetz et al. 2007). For this reason, the relative abundance of smaller fish is likely biased too low (Reynolds 1996). Collection of fish by netting may be associated with bias. Daugherty and Sutton (2005) demonstrated that capture efficiency was affected by moderate flow rates due to movement of fish out of range of the netters. Schoenebeck and Hansen (2005) indicated how gear saturation caused electrofishing catch rate to be non-linearly related to abundance. Some fish may be less likely to be immobilized by electrofishing gear. Dolan and Miranda (2003) demonstrated how immobilization thresholds were inversely proportional to body size. Conductivity, water temperature, water transparency, dissolved oxygen, depth, flow, and electric current are some of the factors that can impact the efficiency of electrofishing gear (Reynolds 1996; McInerny and Cross 2000; Speas et al. 2004; Buckmeier and Schlechte 2009).

2.2.3.5 **Development of Estimates**

Relative abundance of striped bass for each sample was computed as the number of striped bass collected per hour of pedal time of electrofishing (fish/h). For the Tar and Neuse rivers, relative abundance indices and associated standard errors were calculated for all samples each year. For the Cape Fear River, relative abundance and associated standard errors were calculated for each of the three sample sites and for all sites combined. Annual length-frequency distributions were graphically examined using density ridgeline plots (R packages ggplot2 and ggridges; Wickham 2009; Wilke 2019). Fish age and the proportion of non-hatchery fish were determined using PBT when possible. Ages derived using PBT were used in the matrix model.

2.2.3.6 **Estimates of Survey Statistics**

Tar River

Electrofishing surveys in the Tar River yielded 10,933 individual striped bass from 1996–2018. Total catch ranged from 180 fish in 2017 to 1,429 fish in 2005, and relative abundance ranged between 18.2 and 99.8 fish/h (Table 2.6). Other than peaks in 2005 and 2010, relative abundance was consistently between 25 and 50 fish/h throughout the time series, and an obvious temporal trend was not apparent (Figure 2.26). However, abundance declined during the 2016 to 2018-time period, with the lowest mean CPUE of the survey (18.2 fish/h) occurring in 2018. Striped bass ranged in size from 155–1,190 mm. Length distribution of the Tar River striped bass population was typically unimodal, and the modes progressed in size for several years, suggesting persistence of periodic, strong year classes (Figure 2.27). A high percentage of hatchery fish (83–93%) contributed to Tar River striped bass samples between 2013 and 2016, but the proportion of non-hatchery fish increased in 2017 (30%) and 2018 (59%; Table 1.2)

Neuse River

A total of 4,866 striped bass were collected in the Neuse River electrofishing survey from 1994–2018. Total catch ranged from 58 fish in 2006 to 401 in 2003, and the relative abundance index ranged between 4.4 and 20.4 fish/h (Table 2.7). No trend in relative abundance was apparent since 1994, despite the removal of Quaker Neck dam in 1998 and implementation of conservative harvest limits in 2008 (Figure 2.28). Striped bass have ranged in length from 185–1,140 mm. Length distributions of Neuse River electrofishing samples were typically unimodal and the peak of the distributions occurred around 500 mm or 600 mm (Figure 2.29). Analysis of hatchery contribution indicated the Neuse River striped bass population is mostly composed of stocked fish (Table 1.2). The fish of unknown origin in most years were all large enough to be fish stocked prior to 2010 and therefore not eligible for identification by PBT. In 2018, however, 17% of fish less than 550 mm were non-hatchery.

Cape Fear River

Total catch of striped bass ranged from a low of five fish in 2006 to a high of 202 fish in 2016 (Table 2.8). Striped bass ranged in length from 158–891 mm. The oldest PBT-aged fish was an age-8 male collected in 2018 and age 8 was the maximum possible PBT age in that survey year. There was little trend in relative abundance for all sites combined throughout the time series; however, the relative abundance index increased at Lock and Dam 1 after the construction of the rock arch rapids in 2012 but has been followed by a declining trend since 2016 (Figure 2.30). Relative abundance has remained low at lock and dams 2 and 3, indicating few fish are migrating above Lock and Dam 1. Length distribution increased between 2007 and 2012 as the stock expanded following the initiation of annual stocking in 1998; however, length distributions are truncated throughout the time series, with few larger (e.g., ≥ 700 mm) fish occurring in the survey (Figure 2.31). Additionally, PBT analysis indicates the stock is overwhelmingly hatchery-origin fish (e.g., 93% in 2018; Table 1.2).

2.2.4 Cape Fear Tagging Program

2.2.4.1 **Survey Design & Methods**

In 2011, the NCDMF and NCWRC initiated a fishery-independent mark-recapture study to estimate the total mortality and population size of Cape Fear River striped bass using a tag return model. All healthy striped bass were tagged using internal anchor tag and passive integrated transponder (PIT) tags; only data from PIT tagged fish were used for the model. A combination of electrofishing and hook-and-line gears are used to capture fish throughout the Cape Fear River and its tributaries (Figure 2.32). A boat-mounted electrofishing unit (Smith-Root 7.5 GPP) is the primary gear used (2 dip netters) to catch and tag striped bass. A combination of continuous and ambush (intermittent) electrofishing was used during daylight hours. Continuous shocking assures that all habitat types are sampled and particular habitat types are not preferentially selected. To minimize size selection during sampling, striped bass were netted as they were encountered regardless of size.

Striped bass were also tagged using hook-and-line gear during the Cape Fear River Watch Striped Bass Tournament and by a volunteer recreational fisherman trained by NCDMF staff. Additional fish were tagged using run-around gill nets by NCDMF staff to supplement tagging when environmental conditions were not conducive for electrofishing and as part of targeted sampling for the NCDMF Multispecies Tagging Program. Striped bass captured in the Cape Fear River in NCDMF Independent Gill-Net Surveys (Program 915) were also tagged and released if in good condition.

2.2.4.2 **Sampling Intensity**

Sampling within the Cape Fear River and its tributaries (Brunswick, Black, and Northeast Cape Fear rivers) was conducted by the NCDMF from January to April 2011–2018 (Figure 2.32). Sampling on the Cape Fear River spawning grounds was conducted by the NCWRC at the base of the three lock and dams from April–June; however, additional samples were collected as part of NCDMF P366 (Multi-Species Tagging Program) throughout the year.

2.2.4.3 **Biological Sampling**

All striped bass were scanned for existing PIT tags by NCDMF and NCWRC staff prior to being tagged with an internal anchor tag and an PIT tag. Tagged fish were measured to the nearest millimeter for FL and TL and weighed to the nearest 0.01 kilogram (kg).

2.2.4.4 **Potential Biases & Uncertainties**

PIT tag retention was assumed to be 100% and the tag reporting rate was assumed to be 100% because the tag can only be returned by the NCDMF and NCWRC staff through fishery-independent surveys. No angling fishing effort was involved, so the tagging data cannot inform fishing mortality and cannot separate fishing and natural mortalities. Striped bass with estimated ages of 3–7 were tagged in the study, so the estimates only apply to age 3–7 striped bass.

2.2.4.5 **Development of Estimates**

Prior to October 1, 2014 all data on striped bass tagged and recaptured as part the Cape Fear River Striped Bass Mark Recapture Study were entered in the NCDMF Biological Database (BDB) according to the Program 311 documentation. As of October 1, 2014, all data are entered into the BDB under the Program 366 documentation (Multi-Species Tagging Program). Following the transition period between tagging programs, data collected in Program 311 was reformatted to match the Program 366 documentation to allow recaptured fish to be linked back to the original tagging event in Program 311 and to be accounted for in the new multi-species tagging program (P366) upon re-release.

Data were extracted from the NCDMF Biological Database (BDB) and transformed into a PIT tag matrix. Only fish that were PIT tagged using electro-fishing and hook-and-line gears within the selected time period of 2012–2018 were included as releases. To minimize bias associated with higher post-release mortality, fish tagged using gill nets were excluded from the analysis. Data from the 2011 field season were excluded from the analysis due to low sample size (n=265) and to limit the chance of selection bias. Only tagged fish that were recaptured after seven days at large were included as recapture events. In addition, only the fishery-independent PIT tags recaptures by NCDMF and NCWRC staff were included in the analysis. Recreational anglers were not provided PIT tag readers. Multiple recapture events of the same individual were also removed from the analysis. Also, for ease of analysis, all tagging and recapture events were merged into a single recapture category for the matrix. Missing FL and TL were estimated using: FL = (TL * 0.945673822) – 5.277089838 or TL = 6.206909513 + (1.055954699 * FL; see Appendix 1).

2.2.4.6 **Estimates of Survey Statistics**

A total of 3,760 striped bass were tagged and released with PIT tags using all gears from 2011 to 2018 (Table 2.9); however, only 3,450 striped bass were included in the tagging model from 2012 to 2018 (Table 2.10). The majority (88%) of the striped bass included in the model were captured using electrofishing gear. Of the fish included in the model, NCDMF tagged 2,507 striped bass in the mainstem of the Cape Fear River and its tributaries (Figure 2.32). The NCWRC tagged 585 striped bass included in the model on the spawning grounds at lock and dams 1, 2, and 3. Volunteer anglers tagged 358 of the striped bass included in the model using hook-and-line gear at various locations in the Cape Fear River and its tributaries as well as the Northeast Cape Fear River.

Mean length of striped bass that were included in the model ranged from 508.5 mm TL in 2015 to a high of 569.0 mm TL in 2018 (Table 2.11). Minimum TL of tagged striped bass ranged from 192 to 337 mm. Maximum TL of tagged striped bass ranged from 800 to 891 mm. The length-frequency distribution of fish included in the model had bimodal peaks at 375 and 500 mm TL length classes (Figure 2.33). Volunteer anglers using hook-and-line gear primarily tagged larger striped bass, while NCDMF and NCWRC staff tagged fish over a wider range of sizes (Table 2.11; Figure 2.33). Using the results of the 2016 and 2017 genotyping and parentage analyses of Cape Fear River striped bass (Figure 2.34), the length-frequency distribution of striped bass included in the tagging model are thought to represent age three to seven striped bass.

A total of 259 striped bass were recaptured from all gears from 2011 to 2018 (Table 2.12). Two-hundred and twenty-one tag returns (6.4% return rate) from electrofishing gear were included in the tagging model from 2012 to 2018 (Table 2.13). Annual return rates ranged from 1.3% (2018) to 11.8% (2013). Striped bass were recaptured in all sampling areas (Brunswick River, Cape Fear River, Northeast Cape Fear River, and at lock and dams 1, 2, and 3); however, most of the recaptures occurred near downtown Wilmington, North Carolina (Figure 2.35). Distance between release and recapture sites ranged from 0 to 65.0 miles with an average of 6.5 miles and a median distance traveled of 1 mile (Table 2.14). Time at large ranged from 8 to 2,232 days with a mean time at large of 457.5 days (Table 2.15).

Mean length of recaptured striped bass included in the model ranged from 481.2 mm TL in 2018 to 611.6 mm TL in 2012 (Table 2.16). Minimum TL of recaptured striped bass ranged from 359 to 469 mm. Maximum TL of recaptured striped bass ranged from 534 to 845 mm. The length-frequency distribution of recaptured striped bass included in the model had had bimodal peaks at 550 and 650 TL size classes and had a similar distribution as those tagged (Figures 2.33, 2.35). Growth varied by time at large, ranging from 0 to 367 mm (Table 2.17). Twenty negative growth values were removed from the growth estimates and were the result of measuring errors. The mean annual growth rate for all recaptured fish included in the tagging model was 0.190 mm/day and ranged from 0.162 to 0.243 mm/day (Table 2.18).

3 DEMOGRAPHIC MATRIX MODEL

3.1 Objectives

Objectives of this analysis were to (1) estimate the growth of striped bass in each of the three CSMA rivers (Tar-Pamlico, Neuse, and Cape Fear rivers) using von Bertalanffy growth (VB) model; (2) estimate age-specific natural mortality using the Lorenzen method and growth parameters; (3) develop a demographic matrix model for each system; (4) conduct sensitivity and elasticity analyses to identify critical age classes and demographic parameters for sustaining population growth; (5) evaluate efficacy of hypothetical restoration strategies to aid in management of striped bass and to prioritize recovery efforts in these three rivers. Objectives (1) and (2) provide information on demographic parameters used in the matrix model. The demographic matrix model does not provide population abundance or mortality estimates.

3.2 Methods

3.2.1 Demographic Matrix Model

An age-structured demographic matrix model was developed to forward project population dynamics for striped bass (Quinn and Deriso 1999; Caswell 2001). In the matrix model, the population vector of abundance N_y in year y is multiplied by the projection matrix A to obtain the population vector of abundance in year y+1. The top row of the projection matrix specifies the fertility for each age group, which serves as the renewal part of the model. The sub-diagonal of the projection matrix specifies the survival for each age group. The matrix model takes the form as below:

$$N_{y+1} = AN_y,$$

where $N_y = [N_{y,1}, N_{y,2}, \ldots, N_{y,T}]$ is a vector of age-specific population size (i.e., number of individuals) from age one to age T in year y, where T is the maximum observed age for striped bass. In this study, $T = 7$ for Cape Fear River and $T = 11$ for Neuse and Tam-Pamlico Rivers based on survey data (previously described programs, with the exception of Program 100) with striped bass otolith and PBT ages (. Notation A represents the projection matrix with a size of $T \times T$:

$$A = \begin{bmatrix} f_1 & f_2 & \cdots & f_{T-1} & f_T \\ S_1 & 0 & \cdots & 0 & 0 \\ 0 & S_2 & \cdots & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & \cdots & S_{T-1} & 0 \end{bmatrix},$$

where f_t, $t = 1, 2, \ldots, T$ is the fertility (i.e., number of actual recruitment produced per individual) for age t, and S_t is the probability of individuals surviving from age t to the next age class (or from one year to the next year) and can be calculated as:

$\boldsymbol{S_t = \exp(-M_t)}$ for non-harvested population, and

$\boldsymbol{S_t = \exp(-M_t - F_t)}$ for harvested population,

where M and F are instantaneous natural and fishing mortality (per year). Values for f and S are non-negative by definition. In this study, the age-specific natural mortality M_t was estimated using growth information (Section 3.2.2).

The age-specific population abundance can be forward projected by using the projection matrix, which will eventually become stationary. The dominant eigenvalue of this projection matrix (A) equals the population growth rate (λ); the right and left eigenvectors of the projection matrix give the stable size structure of the population and the reproductive contribution of each age class, respectively (Caswell 2001).

3.2.2 Growth

In this study, the von Bertlanffy growth (VB) model was used to describe individual growth (von Bertalanffy 1938):

$$L_{i,j} = \left(L_{\infty,j}\left(1-\exp\left(-K_j\left(t_{i,j}-t_{0,j}\right)\right)\right)\right)\exp\left(\varepsilon_{L,i,j}\right),$$

$$\varepsilon_{L,i,j} \sim N\left(0, \sigma^2_{L,j}\right),$$

where j indexes the jth population, L_∞ is the asymptotic length (mm), K is the Brody growth coefficient (yr^{-1}), t_0 is the age at which fish has a length of zero, L_i and t_i are the length and age of each individual i, respectively. The observed individual length $L_{i,j}$ was assumed to follow a lognormal distribution.

In this study, a Bayesian hierarchical approach was used to estimate parameters, in which priors for the growth parameters ($L_{\infty,j}$, K_j, and $t_{0,j}$) in the VB model were hierarchically structured. The growth parameters were assumed to vary across populations but were constant over time. Specifically, logarithm of population-specific parameters $L_{\infty,j}$, and K_j were assumed to follow a multivariate normal distribution (*MVN*), and $t_{0,j}$ to follow a normal distribution which were further governed by population-average parameters:

$$\begin{bmatrix} \ln L_{\infty,j} \\ \ln K_j \end{bmatrix} \sim MVN\left(\begin{bmatrix} \ln \bar{L}_\infty \\ \ln \bar{K} \end{bmatrix}, \Sigma\right),$$

$$t_{0,j} \sim N\left(\bar{t}_0, \sigma^2_{t0}\right),$$

where $\bar{L}_\infty$, $\bar{K}$ and $\bar{t}_0$ are population-average parameters describing the growth across populations, and they further follow a uniform distribution. The standard deviation σ_{t0} was also uniformly distributed. The $\sum$ denotes the variance-covariance matrix that was modeled with an inverse-Wishart distribution (Gelman and Hill 2007):

$$\Sigma = \begin{bmatrix} \sigma^2_{L\infty} & \varphi \\ \varphi & \sigma^2_K \end{bmatrix},$$

where $\sigma_{L\infty}$ and σ_K are standard deviations of $\ln L_\infty$ and $\ln K$ across populations, and represent spatial variability in growth; φ is the covariance of $\ln L_\infty$ and $\ln K$ across populations. To improve model convergence given highly negatively correlated L_∞ and K in VB model, these two parameters were jointly modeled with a negative correlation (Kimura 2008; Midway et al. 2015).

The posterior distribution was obtained through the Metropolis-Hasting algorithm using Markov Chain Monte Carlo (MCMC) simulation (Hilborn et al. 1994; Hoff 2009). Three concurrent chains were run with a total of 100,000 iterations for each chain. The first 70,000 iterations were discarded as burn-in and every 10th of the remaining samples from each chain were saved for analysis. The JAGS (version 4.0.1) was used to run the Bayesian analysis. The data collected from the above fishery-independent surveys during 2004 to 2017 were used to fit the VB growth model.

3.2.3 Mortality

The Lorenzen method (Lorenzen 2000; Lorenzen 2005) was used to estimate age-specific natural mortality (M_t) for striped bass, which assumes M_t is inversely proportional to the length at age t (L_t):

$$M_t = M_0 L_t^d,$$

where $M_0 > 0$ and $d < 0$ are constants. The constant M_0 can be determined by setting the integral of M_t equal to the integral of a constant natural mortality M_c:

$$\int_{t_{\min}}^{t_{\max}} M_t \, dt = M_c \left(t_{\max} - t_{\min} \right),$$

where t_{max} and t_{min} are the maximum and minimum ages for calculating M_t. In this study, $t_{max} = 7$ for Cape Fear River, $t_{max} = 11$ for Neuse and Tar-Pamlico Rivers, and $t_{min} = 1$ was fixed for all three rivers. Let $d = -1$ and L_t following the VB growth model, i.e., $L_t = L_\infty \left(1 - \exp\left(-K \left(t - t_0 \right) \right) \right)$, then M_0 can be solved as:

$$M_0 = \frac{M_c \left(t_{\max} - t_{\min} \right) L_\infty K}{K \left(t_{\max} - t_{\min} \right) + \ln \left(\dfrac{1 - \exp\left(-K \left(t_{\max} - t_0 \right) \right)}{1 - \exp\left(-K \left(t_{\min} - t_0 \right) \right)} \right)}.$$

In this study, L_∞ and K were set to be the posterior medians estimated from the above growth analysis (Section 3.2.2; Table 3.1). Because natural mortality is one of the most uncertain and difficult-to-estimate parameters in stock assessments (Vetter 1988; Clark 1999), M_c was modeled using a hierarchical structure in this study. Compared with a non-hierarchical model where the projection matrix is further governed by parameters, in a hierarchical model, both parameters and hyper-parameters determine values in the projection matrix (Caswell 2001; Jiao et al. 2009; Li and Jiao 2015). In the hierarchical model, the M_c followed a normal distribution $N\left(\bar{M}, \sigma_M^2 \right)$ with a mean natural mortality $\bar{M}$ and a standard deviation σ_M, and the mean was further governed by hyper-parameters m_1 and m_2 in a uniform distribution $U(m_1, m_2)$:

$$M_c \sim N\left(\bar{M}, \sigma_M^2 \right),$$

$$\bar{M} \sim U\left(m_1, m_2 \right).$$

In this study, the standard deviation of natural mortality (σ_M) was calculated as:

$$\sigma_m = CV \times \bar{M},$$

where CV is the coefficient of variation and was randomly assigned a value between 20 and 40%, which has been used as a reasonable uncertainty level in fisheries data analyses (Jiao et al. 2009; Li and Jiao 2015). In this study, $m_1 = 0.6$ and $m_2 = 1$ for age 1–3, and $m_1 = 0.1$ and $m_2 = 0.5$ was fixed for age 4+. Such parameter values resulted in a natural mortality pattern (Figure 3.1) that approximates previous estimates for striped bass in Neuse River (Bradley et al. 2018b).

The fishing mortality (F) can be scaled by the age-specific fishery selectivity (g_t) to obtain the age-specific fishing mortality (F_t):

$$F_t = Fg_t \, .$$

In North Carolina, no striped bass harvest is allowed in the Cape Fear River whereas both commercial and recreational harvest occurred in Neuse and Tar-Pamlico rivers prior to spring 2019. In this study, fishery selectivity was estimated (Table 3.1) using 2017 fishery-dependent data for Neuse and Tar-Pamlico rivers and using 2017 fishery-independent data for the Cape Fear River (see section 6). The previous estimates for fishing mortality in the Neuse River ranges from 0.53 to 0.71 (Rachels and Ricks 2015; Bradley et al. 2018b). Therefore, in this study, the matrix model was tested at six fishing intensities (i.e., F = 0, 0.2, 0.4, 0.6, 0.8, 1) to represent possible fishing intensities in these three systems.

3.2.4 Reproduction

In this study, a pre-breeding population was assumed and thus, the age-specific fertility (f_t) is a product of the age-specific fecundity (E_t, the number of eggs produced per mature female), the proportion of viable eggs (x), the survival of offspring from birth to next census (S_0, i.e., the survival of offspring through the first year), and the age-specific maturity (w_t):

$$f_t = E_t \times x \times S_0 \times w_t \times 0.5,$$

where the value of 0.5 was multiplied because a 1:1 sex ratio was assumed. In this study, x = 0.64 based on a study for the Neuse River (Buckley et al., 2019), and S_0 = 0.000017 based on a single field study that measured the survival of eggs, yolk-sac larvae (from hatching to complete absorption of yolk-sac), and postlarvae (from yolk-sac absorption to demersal or fully developed juvenile) for striped bass (Table 1 in Dahlberg 1979).

In this study, the age-specific fecundity (E_t)) was derived from the survey data collected from the Neuse River and Tar-Pamlico River during 2013–2014 (Knight 2015):

Cape Fear: $\ln(E_t) = 12.484 + 0.205t$,

Neuse: $\ln(E_t) = 12.52 + 0.214t$,

Tar-Pamlico: $\ln(E_t) = 12.429 + 0.203t$,

where t is age, and the relationship for Cape Fear River was developed by pooling all data from the Neuse River and Tar-Pamlico River because no fecundity data are available for the Cape Fear River.

In the survey data for Neuse and Tar-Pamlico rivers, striped bass older than three years old are 100% mature (Knight 2015); however, striped bass in the Roanoke River may reach 100% maturity at age five or six (Olsen and Rulifson 1992; Boyd 2011). Therefore, in this study, $w_i = 0$ for age ≤ 2 and $w_i = 1$ for age ≥ 5. Due to uncertainty in maturity estimates for ages 3–4, similar to natural mortality, a hierarchical structure was developed to describe the maturity for these two ages:

$$w_i \sim N\left(\bar{w}, \sigma_w^2\right),$$

$$\bar{w} \sim U\left(w_1, w_2\right),$$

$\sigma_w = CV \times \bar{w}$,

where CV = 20-40%, w_1 = 0.29 and w_2 = 1 for age 3, and w_1 = 0.94 and w_2 = 1 for age 4.

3.2.5 Elasticity and Sensitivity

In a demographic matrix model, elasticity analysis can help compare the relative influence of different age classes to the population growth rate (λ), and therefore identify critical age classes to focus on in management. The elasticity is defined as the proportional change in population growth rate in response to the proportional change in matrix parameters θ (Caswell 2001). The definition of sensitivity is similar to elasticity except that sensitivity is defined using the absolute change in growth rate and in matrix parameters. In this study, elasticity was calculated through Monte Carlo simulation (Jiao et al. 2009; Li and Jiao 2015):

Elasticity $\frac{\theta}{\lambda}\frac{d\lambda}{d\theta} = \frac{\theta}{\lambda}\frac{\Delta\lambda}{\Delta\theta}$,

Sensitivity $\frac{d\lambda}{d\theta} = \frac{\Delta\lambda}{\Delta\theta}$,

where θ can be survival or fertility for each age class.

3.2.6 **Evaluation of Fishery Management Strategies**

In this study, five stocking strategies were evaluated and under each stocking strategy, six fishing strategies were tested. Simulations were run for the Neuse River only because the conclusions would be consistent across rivers given the similar life history characteristics among populations. In the stocking scenarios stocked fish were assumed to be age 1; Phase II fish are hatched in the spring and released in the winter near the end of their first year of life. The five stocking strategies included: (1) no stocking; (2) stocking 100,000 fish per year with 2-years stocking and 2-years no stocking alternating for 15 years (8 years of stocking in total); (3) stocking 500,000 fish per year with 2-years stocking and 2-years no stocking alternating for 15 years (8 years of stocking in total); (4) stocking 100,000 fish per year with 8-years continuous stocking; (5) stocking 500,000 fish per year with eight-years continuous stocking.

The six fishing strategies included: (1) baseline scenario in which the fishing mortality was set at F = 0.53 based on the estimates for Neuse River (Bradley et al., 2018b); the fishery selectivity in Table 3.1 was used; the fishery selectivity in Table 3.1 was used; (2) 26-inch (approximately five years old) minimum size limit scenario in which fishery selectivity g_t = 1 for fish of five years and older and g_t = 0 for fish younger than five years; (3) 2-year closure scenario in which F = 0 for the first two years; (4) 5-year closure scenario in which F = 0 for the first five years; (5) 10-year closure scenario in which F = 0 for the first 10 years; (6) a scenario with 5-year closure, followed by 26-inch minimum size limit.

A 15-year time period was used according to Morris and Doak (2004) who suggests a minimum number of ten years to examine the population trend in the population viability analysis. Additionally, a 15-year time period is relatively sufficient given the observed maximum age of striped bass (11 years) in our study systems. The initial population size was set at 5,000 fish. The initial size structure was constructed based on information from the most recent surveys on the Neuse River (North Carolina Wildlife Resources Commission, personal communication; Table

3.2). The adult abundance (age ≥ 3 year) and old adult (age ≥ 6 year) abundance over time was tracked for each scenario. Results were obtained from 10,000 Monte Carlo simulation runs. For each run, parameter values in the projection matrix were randomly drawn from corresponding statistical distributions. Extreme values (i.e., within 2.5% of the lower and upper bounds of the distribution) were discarded to avoid unrealistic combinations of parameter values.

3.2.7 Results

The Neuse River had the largest population growth rate estimates with medians ranging from 0.87 to 1.13, followed by Tar-Pamlico (medians ranging from 0.86 to 1.1) and Cape Fear rivers (medians ranging from 0.75–1.01; Table 3.3). Estimated population growth rates and the probability of population increasing (i.e., Pr ($\lambda > 1$)) declined with increased fishing intensity. Even without fishing allowed, the striped bass in these three rivers would barely sustain, with the medians of population growth rate being slightly above one, and the probability of population growing ranging from 0.52 to 0.8. At fishing mortality rates ≥ 0.4, median population growth rates for all three populations dropped below one, and there was less than 50% probability that the population would grow.

Elasticity of population growth rate to survival and fertility and age-specific reproductive contribution showed similar patterns across three rivers (Figure 3.2). Regardless of fishing intensity, survival and fertility of younger fish influenced population growth rate more than older-age fish, whereas older fish contributed more than younger fish to reproduction due to higher fecundity. As fishing mortality increased, the influence of older fish survival and fertility on the population growth rate decreased, while the influence of younger fish increased. Population growth rate was sensitive to the proportion of viable egg, and age-0 survival but not to the asymptotic length parameter in the growth model (Figure 3.3). As the viable egg proportion and age-0 survival increased, population growth rate estimates increased.

Stocking scenarios produced greater abundance than the scenario with no stocking, and stocking more fish resulted in greater abundance than stocking fewer fish (Figures 3.4 and 3.5). Regardless of stocking strategy, the fishing strategy with 10-year closure was most effective to increase abundance for adults (age 3+), followed by the strategy with 5-year closure combined with 26-inch size limit after closure. The 26-inch size limit strategy was competitive with the closure-size limit combo strategy to increase adult and older adult abundance in stocking scenarios. However, in the no stocking scenario, it was far less effective than the combo strategy. Although 10-year closure was the most effective for age-3+ adults during the first 13 years of simulation, its effectiveness to increase old adult abundance was reduced dramatically once the closure ended and fishing selectivity reverted to the 18-inch size limit, and it became less effective than the combo strategy in no stocking scenario, and less effective than both the 26-inch size limit strategy and the combo strategy in stocking scenarios during the last two years of simulation (Figure 3.5).

3.3 Discussion

Fishing activities driven by fishery selectivity that targets older and larger fish not only reduce fish abundance but also alter age structure of the population. As fishing intensity increased, the influence of older fish survival and fertility to population growth rate decreased in response to massive reduction in their abundance due to fishing. The influence of younger fish survival and fertility increased as fishing mortality increased due to their increased proportion in population abundance. Reproductive contribution by each age group depends on both abundance and fertility of the age group. Although fishing reduces abundance of older fish faster than younger fish, older fish have far greater fertility than younger fish. Thus, the fertility of young fish is too low to offset the reduction in its abundance, and its reproductive contribution became smaller as fishing mortality increased. As the reproductive contribution of younger fish declined with increased fishing mortality, the contribution of older fish rose. This is congruent with Secor (2000), who found that older striped bass contribute far more to reproduction than young age classes, even in populations experiencing fishing mortality. Given that fishing mortality typically impacts older age-classes more than younger age-classes, it is apparent that even relatively moderate levels of fishing mortality can substantially reduce the reproductive potential of a population.

Sensitivity analysis suggests the demographic matrix model is very sensitive to several assumed values. Choice of age-0 survival (S_0) has the greatest influence on model results, with relatively small parameter changes resulting in dramatic changes to the population growth rate (see Table 3.3). In fact, the modeled variability in S_0 was likely minimal compared to realized S_0 in systems with natural striped bass recruitment, which regularly experience order-of-magnitude changes (e.g., Cowan et al. 1993; Martino and Houde 2010). Regardless, the choice of any S_0 is arbitrary as PBT analyses and NCDMF juvenile surveys have demonstrated little age-0 survival in all three systems. This prevents interpretation of the estimated level of the population growth rates; rather, the demographic matrix model best serves as a comparison of the relative efficacy of the several management scenarios investigated.

Finally, the maximum age in each river system was based on the oldest observed fish aged using either PBT or otoliths. NCWRC scale-aged fish have demonstrated longevity greater than the modeled maximum age in each system, and striped bass are known to reach ages in excess of 20 years throughout their range including stocks in other regions. Research has found, however, that scales underestimated ages of older fish when compared to otoliths (Welch et al. 1993; Secor et al. 1995; Liao et al. 2013). Additionally, results of the Age Comparison study (see section 7) show that otoliths provide a more precise and accurate age estimate for CSMA striped bass when compared to scales. Nevertheless, the demographic matrix model results as evaluated with a maximum age of 7 years in the Cape Fear River and 11 years in the Neuse and Tar-Pamlico rivers are likely conservative; models that allow survival to older age classes will likely result in greater divergence in model results among the fishing mortalities investigated.

4 TAGGING MODEL

4.1 Objectives

Objectives of this analysis were to (1) estimate total mortality of striped bass (*Morone saxatilis*) in Cape Fear River using a tagging model; (2) estimate abundance of striped bass in Cape Fear River based on Jolly-Seber method.

4.2 Methods

4.2.1 Tagging Data

PIT tagging data from 2012 to 2018 were used in this analysis. No recreational fishing effort was involved in this study; PIT tags could only be returned by NCDMF or NCWRC staff through fishery-independent surveys. The tagging data cannot inform fishing mortality and cannot separate fishing and natural mortalities, and thus only total mortality was estimated in this study. Striped bass ages were estimated to range from 3–7 years old based off of length frequency data, so the estimated total mortality only applies to striped bass ages 3–7.

4.2.2 Tagging Model

In the tagging model (e.g., Jiang et al. 2007; Bacheler et al. 2009; Ellis et al. 2018), the observed number of tags returned from fish tagged and released in period *i* and captured in period *j* ($j \geq i$), X_{ij}, follows a multinomial distribution with parameters R_i and P_{ij}. The parameter R_i is the total number of tags from fish tagged and released in period *i*, P_{ij} is the probability of a tag returned from a fish tagged and released in period *i* being captured in period *j*. In the model, $\sum_j X_{ij} = R_i - X_{i,\ unknown}$ and $\sum_j P_{ij} = 1 - P_{i,\ unknown}$ where $X_{i,\ unknown}$ and $P_{i,\ unknown}$ are the total number of tags and the probability of a tag returned from fish tagged and released in period *i* with unknown destiny (i.e., have never been captured) by the end of the study period. The parameter P_{ij} can be estimated as follows:

$$P_{ij} = \phi\lambda\rho S_c \left(1 - S_{ij}\right)\frac{U_j}{U_j + Z_j + \Omega},$$

$$S_{ij} = \begin{cases} \exp\left(-U_j - Z_j - \Omega\right) & \textit{when survey occurs in period } j \\ \exp\left(-Z_j - \Omega\right) & \textit{otherwise} \end{cases},$$

where S_{ij} is the survival of tags in period *j* from fish tagged and released in period *i*, ϕ is survival from tagging procedure, ρ is immediate tag retention probability, λ is tag reporting rate, and Ω is tag loss. In this study, PIT tags were used and only NCDMF and NCWRC staff can return the tags through a fishery-independent survey, and thus it was assumed that $\phi = 1$, $\rho = 1$, $\lambda = 1$ and $\Omega = 0$. The parameter S_c is cumulative survival of tags from fish tagged and released in period *i* before being captured in period *j* and can be calculated as:

$$S_c = \begin{cases} 1 & \textit{when } j = i \\ \prod_{v=i}^{j-1} S_{iv} & \textit{when } j > i \end{cases}.$$

Major assumptions for the tagging model in this study include: (1) tagged individuals mix completely with untagged population given that there were 7 days allowed for mixing before starting to recapture fish; (2) all tagged individuals have the same survival and recapture probabilities; (3) tagged individuals have independent fates; (4) a monthly time-step is assumed (i.e., *j* represents *j*th month); however, the total mortality was estimated on a yearly basis and was assumed constant over months within the year (i.e., $Z_j = Z_y / 12$), where *y* is the year that month *j* corresponds to; (5) tags from the fish that were caught and released with tag intact were treated as though tags were cut off; the new subsequent captures of those fish were ignored (Bacheler et al. 2009).

4.2.3 Bayesian Estimator

In this study, the Bayesian approach was used to estimate parameters. The posterior probability of a parameter set (θ) given the observed data (X), $p(\theta|X)$ can be calculated as follows:

$$p(\theta|X) = \frac{f(X|\theta)\pi(\theta)}{\int_\theta f(X|\theta)\pi(\theta)d\theta},$$

where $f(X|\theta)$ is the probability density function of the observed data X given the parameter set θ, and $\pi(\theta)$ is the prior probability, i.e., the probability density function of θ. In the tagging model, the observed data X include the number of tags returned from each time period (X_{ij}), and the parameter set θ includes the total number of tags from fish tagged and released (R_i) and the probability of a tag returned (P_{ij}). With multinomial distribution, the density function $f(X|\theta)$ is:

$$f(X_{11},...,X_{IJ}|P_{11},...,P_{IJ}, R_1,...,R_I) = \prod_i \left(\frac{R_i!}{X_{i1}!\cdots X_{iJ}!X_{i,\,unknown}!} P_{i1}^{X_{i1}} \cdots P_{iJ}^{X_{iJ}} P_{i,\,unknown}^{X_{i,\,unknown}} \right),$$

where J is the end return time period and I is the end release time period. The posterior distribution was obtained through the Metropolis-Hasting algorithm using Markov Chain Monte Carlo (MCMC) simulation (Hilborn et al. 1994; Hoff 2009). Three concurrent chains were run with a total of 50,000 iterations for each chain. The first 20,000 iterations were discarded as burn-in and every 10th of the remaining samples from each chain were saved for analysis. The software JAGS (version 4.0.1) was used to run the Bayesian analysis.

4.2.4 Model Priors

Non-informative priors (i.e., uniform priors) were used for parameters in the tagging model, except for total mortality Zy (Table 4.1). In this study, a hierarchical prior was used for *Zy* where *Zy* follows an unknown lognormal distribution centering around $\bar{Z}$ that is further governed by a uniform distribution bounded by z_1 and z_2:

$$Z = \bar{Z}\exp(\varepsilon_Z)$$
$$\bar{Z} \sim Uniform(z_1, z_2),$$

where $\varepsilon_Z \sim Normal(0, \sigma_Z^2)$ is a random error representing the variation in total mortality. Based on previous studies, $z_1 = 0.1$ and $z_2 = 1.5$ (Bradley et al. 2018b).

4.2.5 Abundance Estimate

The Jolly-Seber method (Seber 1982) was used to estimate abundance of age 3–7 striped bass in the Cape Fear River:

$$N_y = \frac{R_y}{\alpha_y},$$

where N is abundance, y indexes year, R is the total number of tags from fish tagged and released, and α is the capture probability, i.e., the probability that a tagged fish is captured. The tag recovery probability can be calculated as:

$$\alpha_y = \left(1-\exp\left(-U_y - Z_y - \Omega\right)\right)\frac{U_y}{U_y + Z_y + \Omega}.$$

4.3 Results

Median estimates of instantaneous total mortality (Z) for age 3 to 7 striped bass ranged from 0.53 (2017) to 1.13 (2014; Table 4.2; Figure 4.1). Total mortality estimates were high in 2012 (median = 0.96; 95% credible interval (CI) = 0.53–1.43) and 2014 (median = 1.13; 95% credible interval (CI) = 0.71–1.47). In 2013, total mortality was low (median = 0.58; 95% credible interval (CI) = 0.21–1.00), and declined in 2015, until another increasing in 2018. Early years (2012–2014) were associated with less uncertainty than the later in the time period (2015–2018).

Abundance estimates ranged from 1,578 (2017) to 10,983 (2012) (Table 4.2; Figure 4.1). Abundance estimates consistently declined over the study period (2012–2018). Abundance in 2018 (median = 1,914; 95% CI = 1,415–,765), was reduced to less than 20% of the abundance in 2012 (median = 10,893; 95% CI = 5,418–23,479). Abundance estimates had greater uncertainty in earlier years of the study period. Median capture probability estimates ranged from 0.04 (2012) to 0.22 (2017; Table 4.2).

4.4 Discussion

Previous estimates of total mortality for adult striped bass in Neuse River, Tar-Pamlico River, and Albemarle Sound-Roanoke River ranged from 0.33 to 1.52 on average (Callihan et al. 2014; Harris and Hightower 2015; Rachels and Ricks 2015; Bradley et al. 2018b). These systems are more intensively subject to fishing than Cape Fear River, which would result in higher total mortality in these systems if assuming similar natural mortality. Total mortality estimates for the Cape Fear River fell within the range from previous studies on North Carolina striped bass.

Collier et al. (2013) estimated total mortality and abundance for adult striped bass in the Cape Fear River using tagging data from 2011 to 2013. The study estimated an average total mortality of 0.24 per year (95% CI = 0.02–0.59), a median annual abundance of 15,209 with a 95% CI between 5,000 and 25,000 (Figure 4.1). The authors reported a capture probability ranging from 0.01 to 0.03. Compared to estimates from Collier et al. (2013), total mortality estimates for 2012 and 2013 had a median of 0.96 and 0.58 respectively, which is three times and 1.4 times greater than their estimates. Estimates of abundance for 2012 was not significantly different from the Collier et al. (2013), and estimates of capture probability for 2012 (median = 0.04; 95% CI = 0.02–0.07) were close to the range reported by Collier et al. (2013); however, abundance estimates for 2013 (median = 4,535; 95% CI = 3,024–6,921) were 70% lower, and capture probability estimates were 3 to 4 times higher than the Collier et al. (2013) estimates (Figure 4.2). Collier et al. (2013) accounted for fish movement between four locations within the Cape Fear River, emigration and immigration, which may have contributed to their lower total mortality estimates, lower capture probability estimates and higher abundance estimates compared to this study. While striped bass in the Cape Fear River are thought to remain in the river year around, Raabe et al. (2019) detected a fish leaving the telemetry array at the river mouth and in 2017 a fish tagged with an anchor tag at Lock and Dam 1 was recaptured by a recreational angler on the Roanoke River.

Estimates of striped bass recreational fishing effort and discards reported by the NCDMF recreational creel survey were substantially higher in 2014 compared to other years (2013, 2015–2018) surveyed (Table 4.3; Figure 4.3), although survey probabilities may be imprecise because they are not set up for striped bass and the estimates have high PSEs. The estimated recreational fishing effort (number of hours fished) was approximately 1.5 times the effort reported in 2016 and three times those in 2013 and 2015; the estimated discards in 2014 were 3 to 64 times higher than other years in the survey. Thus, the high total mortality estimates in 2014 in this study may be caused by high fishing and discard mortalities. In September of 2018, Hurricane Florence made landfall at Wrightsville Beach, North Carolina, causing extensive damage and extreme flooding along the Cape Fear River and its tributaries. Heavy flooding after the storm led to large fish kills due extended periods of hypoxic conditions along the Cape Fear River, likely contributing to the increased mortality estimates observed in 2018. NCDMF staff observed 574 dead striped bass at Battleship Park over the course of two days following the storm (Figure 4.4). Twenty-three anchor tags were recovered from fish tagged with both anchor and PIT tags. NCDMF staff could not access the Wilmington Regional Office due to the hurricane, thus these fish were not scanned to determine if PIT tags were present. If these fish were included in the model, the 2018 total mortality estimates would likely be much higher than those reported for just PIT tag returns alone. The small number of tag returns during 2015–2018 may have also contributed to the high uncertainty of total mortality estimates in this time period. An average of 46 tags were returned per year during 2012–2014, whereas an average of 21 tags were returned during 2015–2018. The low uncertainty in capture probability estimates in early years numerically led to the large variation in abundance estimates given the total number of fish released annually was a known constant.

The use of PIT tags has proven to be an effective means to collect biological data for a variety of species (Gibbons and Andrews 2004; Marvin 2012). While the cost of PIT tags exceeds that of traditional anchor tags, their high retention rate, low mortality associated with tagging, and their ability to retain a fish's identity after multiple recapture events makes them ideal in systems such as the Cape Fear River. In 2019, additional money was secured through the NCDMF's Multi-Species Tagging Program (P366) to continue PIT tagging striped bass in the Cape Fear River. Models used to estimate parameters such as mortality and abundance often have the highest amount of uncertainty for the terminal year. Thus, adding additional years of data to the model should lower the variation in abundance and uncertainty of the total mortality estimates observed during 2015–2018. This additional data should also give managers a better understanding of the true impact of Hurricane Florence on striped bass in the Cape Fear River.

5 GLM ANALYSIS ON COMMERCIAL & RECREATIONAL FISHERIES DATA

5.1 Objectives

The linear regression analysis was extended in Rachels and Ricks (2018) by adding recreational data for the striped bass population in the Neuse River. The goal of this analysis was to identify important factors that influence the response variable (i.e., the relative annual variation in spawning stock mortality). The details of Rachels and Ricks (2018) analysis can be found in Appendix 2.

5.2 Methods

The time period of the analysis was confined to 2004–2015 because recreational data are only available since 2004. Along with the four predictor variables that were used in Rachels and Ricks (2018), namely commercial gill-net effort (number of trips), commercial harvest (kg), summer temperature (ºC) and summer dissolved oxygen (DO, mg/L), five predictor variables were added to represent recreational fishing activities in this analysis. These five recreational variables included recreational effort (number of trips), recreational harvest (kg), recreational discard (number), recreational total catch (number) and recreational total removal (number, catch + dead discard). The same exact assumptions and procedures were followed as in Rachels and Ricks (2018). These assumptions included: (1) a simple linear regression was applied; (2) original data (both response and predictor variables) were transformed by taking the difference between every two years, i.e., the variation relative to previous year (relative annual variation) and the transformed data were then used in the regression; (3) a one-year delay was applied to all predictor variables except commercial harvest. The one-year delay for commercial gill-net and environmental factors were based on Rachels and Ricks (2018), and the one-year delay for recreational variables was based on the same rationale that the recreational fishing occurs in fall, after the survey sampling season for the current year.

The sensitivity of model outcomes to a series of scenarios was explored further (Figure 5.1). These scenarios included a combination of (1) how long time series of data to use, i.e., a time period of 1994–2015 as in Rachels and Ricks (2018) or a shorter time period of 2004–2015 when recreational data are available; (2) whether or not to apply one-year delay to the variable commercial gillnet effort; fishing effort and fishery harvest are generally considered to occur simultaneously and to associate together; (3) whether or not to transform data, i.e., using relative annual variation or using original data; (4) what error distribution to assume when using original data, i.e., normal error as in Rachels and Ricks (2018) or lognormal error that can describe the possible nonlinear relationship between response and predictor variables; lognormal error cannot be applied when using transformed data due to negative values in response variable that are generated during transformation, and thus only normal error was applied. A stepwise variable selection procedure was used to select the most important factors based on Akaike information criterion, AIC (e.g., Li et al. 2016). This procedure starts with a model only including an intercept. At each step, the variable that reduces the AIC value most or shows the most significant effects (i.e., the smallest P-value) on the response variable will be selected into the model. This step is repeated until including an additional variable will not lead to substantial improvement to model goodness-of-fit.

5.3 Results

A total of 31 candidate models were tested, of which eight models had ΔAIC_c values less than two (Table 5.1). In this analysis, the eight candidate models with a ΔAIC_c value less than two are considered equally plausible in terms of goodness-of-fit and parsimony. The variables contained in these eight models included commercial effort, commercial harvest, recreational effort, recreational discard, recreational total catch and recreational harvest. The model with commercial effort had the highest weight (w_i=0.15), followed by the model with commercial effort and commercial harvest (w_i=0.086), the model with recreational effort (w_i=0.081), and the model with recreational discard (w_i=0.071). This result suggested the relative annual variation in both commercial and recreational fisheries related factors such as fishing effort and removal (including harvest and discard) could play an important role in driving the relative annual variation in total mortality of striped bass in Neuse River.

Sensitivity results showed that model outcomes could be very sensitive to the assumptions that were tested (Figures 5.1 A–C). First, commercial gill–net effort being one-year lagged had a great impact on the outcomes, especially when using data from 2004–2015. For example, using transformed data from 2004–2015, when commercial gill–net effort was not one-year lagged, none of the predictor variables were significant, regardless of including recreational information; however, when commercial gill–net effort was one-year lagged, the variables commercial gill–net effort, commercial harvest, and DO were significant (Figures 5.1 B and C). Second, use of transformed data versus non-transformed data greatly influenced the model outcomes, especially for data from 2004–2015. For example, using non-transformed data from 2004–2015 with recreational information considered and no one-year lag being applied to commercial gill–net effort, the variable commercial gill–net effort was selected as the most significant factor, followed by recreational effort and summer temperature; by contrast, none of the variables showed significant impacts when using transformed data (Figure 5.1 C). Third, whether to include recreational information was critical to determine the model outcomes. For example, using non-transformed data from 2004–2015 with commercial gill-net effort being lagged by one year, none of the variables were selected (Figure 5.1 B) whereas the variables recreational effort and summer temperature were significant when adding recreational information, regardless of the model error distribution (Figure 5.1 C). Model error distribution showed little impacts on model outcomes.

5.1 Discussion

Although using different time series of data due to the availability of recreational data, both this analysis and Rachels and Ricks (2018) documented commercial effort as an important predictor of striped bass mortality in the Neuse River. Model averaging analysis by Rachels and Ricks (2018) indicated commercial gill-net effort was far more influential than the other parameters that were examined. Although Rachels and Ricks (2018) did not include recreational effort or harvest due to benefits of the longer available time series for commercial data, the study also acknowledged the potential importance of recreational angling on total mortality of Neuse River striped bass. Results from this analysis indicated recreational effort and recreational discards may indeed be as influential on annual striped bass mortality as commercial effort and commercial harvest.

6 YIELD-PER-RECRUIT

6.1 Objectives

Yield-per-recruit analysis can be used to evaluate the impacts of fishing mortality and selectivity on fishery yield. The analysis can be extended to estimate the spawning potential in a stock under different conditions. The results of these analyses can be used to balance management and biological objectives for the population of interest.

In this report, several per-recruit analyses are applied to data characterizing striped bass collected from the Neuse River during 2017. Yield-per-recruit analysis is used to examine the impacts of various minimum length limits and fishing mortality rates on fishery yield in terms of numbers and weight. Spawning stock biomass- and eggs-per-recruit models were also applied to estimate the spawning potential ratio based on conditions in 2017 and to evaluate how the spawning potential ratio varied under different management scenarios.

Traditional per-recruit analyses have been modified here to allow for age-varying natural mortality and logistic selectivity and to account for both non-hatchery and hatchery-origin fish. Due to low spawning stock sizes and limited recruitment, an annual stocking program has occurred in the Neuse River since 1981 (Table 1.1).

6.2 Methods

6.2.1 Data

6.2.1.1 **Description**

The primary source of data characterizing striped bass in the Neuse River comes from the North Carolina Wildlife Resource Commission's (NCWRC) Spawning Stock Survey (Figure 6.1). The goal is to monitor striped bass migrating to the spawning grounds. The survey occurs in the spring and is conducted using boat-mounted electrofishing gear. Sampling is contingent on adequate streamflow to allow boat access to sites. Effort on any one individual sampling event varied from 11 to 58 minutes during 2017 (Figure 6.2). The median sampling time on an individual trip was 19 minutes. The survey began in 1994. Scales were collected for ageing from 1994 through 2015. Beginning in 2015, genetic ages have been taken. Only genetic ages were used in the analyses in this report.

6.2.2 Initialization

6.2.2.1 **Initial Number of Recruits**

The analyses applied here (see section 6.2.2) track the development of a fixed number of recruits over time. That initial number is simply used for scaling and all final calculations are computed on a per-recruit basis. Here, the initial number of recruits was set at 1,000 individuals.

6.2.2.2 **Age Range**

The minimum age was set at 1 and the maximum age was set at 11. A plus group was set at age 7. The maximum age of 11 was selected based on the maximum (scale) age observed in the NCWRC Spawning Stock Survey since it started in 1994. The plus group was selected based on the maximum age observed in 2017.

6.2.2.3 **Sex Ratio**

In the absence of compelling evidence to the contrary, a sex ratio of 50:50 was assumed in the analyses.

6.2.3 Hatchery Fish

6.2.3.1 **Proportion of Hatchery Fish in Population**

Data on origin (hatchery versus non-hatchery) were collected from 266 striped bass in the Neuse River during 2016 and 2017. Of those individuals, a total of 207 (78%) were of hatchery origin. The per-recruit models assumed that 78% of the population was hatchery-origin fish.

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6.2.3.2 **Initial Number of Recruits**

The length of stocked hatchery fish ranges from 152 millimeters (6 inches) to 203 millimeters (8 inches). The length of stocked hatchery fish assumed in the analyses was 178 millimeters (7 inches). Because the assumed length of stocked hatchery fish is less than the length at age 1 (252 millimeters or 10 inches; section 6.2.4.1), the minimum age used in the analyses, changing this value will not have an impact on any of the results presented.

6.2.4 Growth

Biological data collected from the NCWRC Spawning Stock Survey during 2017 were used in the estimation of growth parameters described below.

6.2.4.1 **Age-Length**

The relationship of age to length was modeled using the von Bertalanffy function:

$$L_t = L_\infty\left(1 - e^{-K(t-t_0)}\right)$$

where L_t is total length in millimeters at age t, L_∞ is the theoretical asymptotic average length (if $K > 0$), K is growth rate at which the asymptote is approached, and t_0 is the hypothetical age at which length is zero.

It was necessary to fit the age-length model using inverse weighting (based on sample size at age) to ensure reasonable parameter estimates due to the low sample sizes at the youngest and oldest ages. The estimated parameters of the von Bertalanffy age-length function are given in Table 6.1 and a graph of the observed and predicted values is shown in Figure 6.3.

6.2.4.2 **Length-Weight**

The relation of length to weight as modeled using:

$$W = aL^b$$

where W is weight in grams, L is total length in millimeters, and a and b are the parameters that are estimated.

The estimated length-weight parameters are given in Table 6.2 and a graph of the observed and predicted values is shown in Figure 6.4.

6.2.5 Mortality

6.2.5.1 **Fully-Recruited Fishing Mortality**

The value assumed for fully-recruited fishing mortality was 0.33 and was derived from a catch curve analysis, which is described in section 6.2.2.1 of this report.

6.2.5.2 **Discard Mortality**

Bradley et al. (2018b) used telemetry and tag reporting data collected from December 2013 through September 2015 to estimate mortality rates of striped bass in the Neuse River. Their estimate of discard mortality was 0.0% so discard mortality was assumed negligible in the per-recruit analyses.

6.2.5.3 **First Length at Capture**

The length at first capture was assumed equal to the current minimum length limit, 457 millimeters (18 inches).

6.2.5.4 **Pre-Spawning Mortality**

Peak spawning in the Neuse River is assumed to occur the second week of April. If natural mortality is assumed to occur equally throughout the year, the proportion of natural mortality that occurs before spawning is 0.35 (4.25/12).

The proportion of fishing mortality that occurs before spawning was estimated by calculating the amount of total catch (commercial plus recreational) that occurs before April. Estimates of commercial landings, commercial discards, recreational harvest, and recreational discards were available by season for 2017. The total catch was computed by season and then the proportion of the total was calculated for each season. The proportion of the total catch occurring in the winter season (January through March) was 0.28. This value (0.28) was assumed for the proportion of fishing mortality that occurs before spawning.

6.2.5.5 **Natural Mortality**

The idea that natural mortality of fishery resources changes with body weight or length is supported by both ecological theory and empirical evidence. For a given species, the youngest life stages tend to experience higher natural mortality than older life stages.

Lorenzen's (1996) approach was used to estimate age-specific natural mortality for striped bass in the Neuse River. This approach requires parameter estimates from the von Bertalanffy age-length growth model (to translate age to length), parameter estimates from the length-weight function (to translate length to weight), and the range of ages for which natural mortality will be estimated.

The growth parameter values reported in section 6.2.1.4 of this report were used to compute natural mortality at ages 1 through 7+, using Lorenzen's (1996) equation. The estimates of natural mortality at age used in the per-recruit modeling are given in Table 2.3 and the relationship is shown in Figure 6.5.

6.2.6 Spawning

6.2.6.1 **Maturity**

A logistic model was used to describe the relationship between total length and maturity based on data collected from the Tar and Neuse rivers in 2013 and 2014 (Knight 2015). Data from the Tar and Neuse rivers were combined because too few immature fish were observed in the Neuse River alone to support modeling. The logistic model used was:

$$mat = \frac{e^{a+bL}}{1+e^{a+bL}}$$

where *mat* is the proportion mature, *L* is total length in millimeters, and *a* and *b* are the parameters that are estimated.

The estimated length-maturity parameter values are given in Table 6.4 and a graph of the observed and predicted values is shown in Figure 6.6. The estimated length at 50% maturity is 471 millimeters total length.

Because no immature fish of non-hatchery origin were observed, it was not possible to consider separate models for non-hatchery and hatchery-origin fish.

6.2.6.2 **Fecundity**

As with the maturity data, fecundity data collected from the Tar and Neuse rivers in the Knight (2015) study were combined to ensure adequate sample sizes for modeling. There were sufficient numbers to model fecundity relationships separately for non-hatchery and hatchery-origin fish. Linear models were used to describe the relationship between total length and fecundity for fish of each origin type. The relationship for non-hatchery origin fish (Figure 6.7) was estimated as:

$$Fecundity = -3{,}222{,}798 + 6{,}365.4622L$$

where Fecundity is the number of eggs produced per female and L is total length in millimeters.

The linear relationship for hatchery-origin fish (Figure 2.8) was estimated as:

$$Fecundity = -1{,}875{,}954 + 4{,}429.5759L$$

An analysis of covariance (ANCOVA) was used to compare the two linear regressions (Zar 1999). The ANCOVA can test whether the slopes and/or intercepts are significantly different from each other. Here, the ANCOVA found the slopes and intercepts to be significantly different, suggesting it was appropriate to use different fecundity models for fish of different origin.

6.2.2 Analyses

A table of symbols, their definitions, and measurement units used in the equations in this section is given in Table 6.5.

6.2.2.1 Catch Curve & Selectivity

A catch curve approach was used to estimate total mortality and selectivity for striped bass. The method developed by Thorson and Prager (2011) estimates logistic selectivity (to avoid the need to choose an age at full selection) in addition to estimating total mortality and incorporates age-varying natural mortality. Traditional per-recruit analyses assume knife-edge selection in which selectivity transitions from 0 at the length (or age) before length (or age) at full recruitment to 1 at the length (or age) at full recruitment. In the analyses here, this assumption was modified to allow for a logistic-shaped selection curve. Selectivity at lengths smaller than the minimum length limit (section 6.2.5.3) was assumed equal to 0 and selectivity at lengths greater than or equal to the minimum length limit was equal to the selectivity predicted by the logistic model (Figure 6.9).

Because the sampling time varied among sampling events (section 6.2.1), the frequency at age was standardized to 19 minutes (Table 6.6). The values assumed for natural mortality at age were those values estimated in section 6.2.5.5 of this report.

Natural mortality at age was subtracted from the estimated total mortality at age for each year to produce annual estimates of fishing mortality at age (Table 6.7). The apical fishing mortality from this vector ($F_{2017} = 0.33$) was assumed for the fully-recruited fishing mortality (section 6.2.5.1) in the per-recruit analyses.

6.2.7 Yield-per-Recruit

Yield-per-recruit models follow a fixed number of recruits and track their growth and mortality over time and evaluate the impacts of various factors on fishery yield. The methods of Thompson

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and Bell (1934) and Ricker (1975) have been modified to allow for more realistic conditions in that the modifications allow for age-varying natural mortality and logistic selectivity (in contrast to knife-edge selectivity). The modified approach also allows for contributions to the stock from both non-hatchery and hatchery-origin fish. Note that the model assumes no migration.

6.2.7.1 **Fishing & Total Mortality**

Fishing mortality, F, at age t was computed as:

$$F_t = F_{full} S_t$$

where F_{full} is the assumed value for the fully-recruited fishing mortality (section 6.2.5.1) and S_t is the vector of selectivity at age (section 6.2.2.1).

Total mortality, Z, at age t was calculated as the sum of natural mortality at age, M_t, and fishing mortality at age:

$$Z_t = M_t + F_t$$

6.2.7.2 **Population Size**

The total population size (in numbers) at the minimum age used in the analyses, age 1, was set equal to 1,000 individuals (see section 6.2.3.2):

$$N_1 = 1{,}000$$

Total population size at ages older than age 1 (in numbers) was calculated using;

$$N_t = N_{t-1} e^{-Z_{t-1}}$$

The weight (kilograms) of the total population at age, B_t, was calculated as:

$$B_t = N_t \left(\frac{w_t}{1{,}000} \right)$$

where w_t is the individual weight at age in grams.

The number of individuals in the population at age of non-hatchery origin, U_t, was computed as:

$$U_t = N_t (1 - h)$$

where h is the assumed proportion of hatchery fish in the population (section 6.2.3.1).

The number of individuals in the population at age that are of hatchery origin, H_t, was calculated as:

$$H_t = N_t h$$

The weights of non-hatchery and hatchery individuals at age were calculated the same way as the total population weight at age.

6.2.7.3 **Catch**

The total number of individuals in the catch at age, C_t, was computed as:

$$C_t = N_t \frac{F_t}{Z_t} (1 - e^{-Z_t})$$

The yield per recruit for the entire population, YPR, in numbers was calculated as:

$$\text{YPR} = \frac{\sum_t C_t}{N_1}$$

The weight (kilograms) of the total catch at age, W_t, was calculated as:

$$W_t = C_t \left(\frac{w_t}{1{,}000}\right)$$

The yield per recruit in weight (kilograms) for the entire population, WPR, was calculated as:

$$\text{WPR} = \frac{\sum_t W_t}{N_1}$$

6.2.8 Spawning Stock Biomass-per-Recruit

The yield-per-recruit analysis can be extended to evaluate the effects of fishing mortality and minimum length limit on spawning potential. The method of Gabriel et al. (1989) has been modified to incorporate age-varying natural mortality.

SSB at age for non-hatchery female fish, SSU_t, in weight (kilograms) was calculated as:

$$\text{SSU}_t = pU_t \left(\frac{w_t}{1{,}000}\right) mat_t e^{-(fF_t + mM_t)}$$

where p is the proportion of individuals in the population that are female (section 6.2.2.3), U_t is the number of individuals in the population that are non- hatchery origin, *mat* is maturity at age t (section 6.2.6.1), f is proportion of fishing mortality that occurs before spawning (section 6.2.5.4), and m is the proportion of natural mortality that occurs before spawning (section 6.2.5.4).

SSB per recruit for the non-hatchery female fish, SSU/R, in weight (kilograms) was calculated as:

$$\text{SSU/R} = \frac{\sum_t \text{SSU}_t}{N_1}$$

SSB at age for hatchery-origin female fish, SSH_t, in weight (kilograms) was calculated as:

$$\text{SSH}_t = pH_t \left(\frac{w_t}{1{,}000}\right) mat_t e^{-(fF_t + mM_t)}$$

where H_t is the number of individuals in the population that are of hatchery origin.

SSB per recruit for hatchery-origin female fish, SSH/R, in weight (kilograms) was calculated as:

$$\text{SSH/R} = \frac{\sum_t \text{SSH}_t}{N_1}$$

SSB per recruit for the entire population, SSB/R, was computed as:

SSB/R = SSU/R + SSH/R

6.2.9 Eggs-per-Recruit

Eggs-per-recruit models estimate the number of eggs, on average, that a single female produces in a lifetime. By comparing the current estimate of eggs per recruit to an estimate computed assuming no fishing, one can calculate the spawning potential ratio, which is a measure of the reproductive health of the stock (see below). Goodyear's (1993) approach has been modified to allow for different assumed fecundity relationships for non-hatchery and hatchery-origin fish.

The total number of eggs at age for the non-hatchery female fish, EU_t, was computed as:

$$\mathrm{EU}_t = \left[pU_t mat_t e^{-(fF_t + mM_t)}\right][-3{,}222{,}798 + 6{,}365.4622L_t]$$

Eggs per recruit for the non-hatchery female fish, EU/R, in numbers of eggs was calculated as:

$$\mathrm{EU/R} = \frac{\sum_t \mathrm{EU}_t}{N_1}$$

The total number of eggs at age for hatchery-origin female fish, EH_t, was computed as:

$$\mathrm{EH}_t = \left[pH_t mat_t e^{-(fF_t + mM_t)}\right][-1{,}875{,}954 + 4{,}429.5759L_t]$$

Eggs per recruit for hatchery-origin female fish, EH/R, in numbers of eggs was calculated as:

$$\mathrm{EH/R} = \frac{\sum_t \mathrm{EH}_t}{N_1}$$

Eggs per recruit for the entire population, E/R, was computed as:

$$\mathrm{E/R} = \mathrm{EU/R} + \mathrm{EH/R}$$

The spawning potential ratio (SPR) is a measure of the reproductive health of the stock based on fecundity that is calculated relative to the virgin stock condition (i.e., unfished stock; Goodyear 1993). SPR was computed as:

$$\%\mathrm{SPR} = \frac{\mathrm{E/R}_{F=F_{full}}}{\mathrm{E/R}_{F=0}}$$

6.3 Approach

The per-recruit analyses were used to estimate SPR based on conditions in 2017 using the values indicated in the descriptions above. Additionally, yield per recruit in both numbers and weight as well as SPR were calculated for combinations of minimum length limits and fully-recruited fishing mortality values. The minimum length limits evaluated ranged from 406 millimeters (16 inches) to 673 millimeters (26.5 inches) at increments of 13 millimeters (0.5 inches). The range of fully-recruited fishing mortality values evaluated was 0.0 to 2.0 at increments of 0.1.

6.4 Results

The per-recruit analyses indicated that SPR based on conditions in 2017 was 44%.

In terms of weight, yield per recruit is maximum at minimum length limits ranging from 508 millimeters (20 inches) to 559 millimeters (22 inches) when fishing mortality rates are at the highest levels evaluated ($F > 1.6$; Figure 6.10). Yield per recruit in terms of numbers is maximized at smaller minimum length limits (<500 millimeters or 20 inches) and fishing mortality rates greater than 0.60 (Figure 6.11). SPR is maximum when fully-recruited fishing mortality is equal to 0.0 (Figure 6.12), which is expected. In the presence of fishing mortality, SPR increases with decreasing fishing mortality and increasing minimum size.

Over the range of fishing mortality rates evaluated, there is not much difference in terms of yield per recruit in weight among minimum size limits less than 610 millimeters (24 inches; Figure 6.13). A different pattern emerges when evaluating yield per recruit in terms of numbers. Regardless of fishing mortality, yield in numbers generally decreases as the minimum size limit increases (Figure 6.14). SPR generally increases as the minimum length increases (Figure 6.15).

At the current size limit, yield per recruit in terms of both weight and numbers is maximized when fully-recruited fishing mortality is 2.0, possibly higher as this was the largest value evaluated (Figures 6.13, 6.14). At a fully-recruited fishing mortality rate equal to 2.0, SPR would be reduced to 10% (Figure 6.15).

6.5 Discussion

Balancing management objectives against biological objectives is often challenging. Increasing the harvest rate (i.e., fully-recruited fishing mortality rate) will result in increased yield per recruit (in weight and numbers) but the spawning potential of the stock will be reduced. Increasing the minimum size limit could increase SPR but would result in increased discards, though the mortality of these discards is currently assumed negligible (section 6.2.5.2; Bradley et al. 2018b).

There are a number of uncertainties in the analyses that affect the interpretation of the results. One important issue is that the estimate of fully-recruited fishing mortality assumed in the analyses is likely inaccurate. The estimate was derived from catch curves based on data collected from spawning fish, which are likely not representative of fish in the catch. Bradley et al. (2018b) estimated mortality rates of striped bass in the Neuse River using telemetry and tag reporting data collected from December 2013 through September 2015. Their estimate of harvest mortality of adult striped bass was 0.131. Assuming this value in the per-recruit analyses results in a SPR value of 69%.

Bradley et al. (2018a, 2018b) estimated a fishing mortality of 0.53 and suggested their reported mortality levels were lower than those outside the study area because fishing practices differed between the study area and the entire area used by the population. Bradley et al. (2018b) also estimated an adult natural mortality rate of 0.24. Bradley et al.'s (2018b) estimates of both fishing and natural mortality were not sex- or age-specific and applied to a range of ages (ages 3 to 9 based on length). The average Lorenzen estimate of M over ages 3 to 9 used in this study is 0.31, which is only slightly higher than 0.24.

Rachels and Ricks (2015) conducted a yield-per-recruit analysis for Neuse River striped bass assuming a fishing mortality rate equal to 0.69 and a natural mortality rate equal to 0.16. They estimated SPR equal to 3% assuming the same minimum size limit as modeled in this analysis (457 mm). The disparity in SPR (3% vs. 44%) and length limits producing maximum yield per recruit between Rachels and Ricks (2015) and this analysis are due to different underlying assumptions regarding Neuse River striped bass growth, longevity, natural mortality, fishing mortality, selectivity, and the contribution of non-hatchery versus hatchery-origin fish.

Rachels and Ricks (2015) assumed a maximum age of 30 years, which has not been observed in the Neuse River stock and so is not reflective of current conditions. Although selection of the maximum age considered can be arbitrary (Ricker 1975), the maximum age used in a YPR analysis, whether 11 years as used here or 30 years as in Rachels and Ricks (2015), can alter model results and should be realistic for the modeled species and system at the time of the analysis.

Assuming an older maximum age in the yield-per-recruit analysis will result in a lower estimate of SPR.

In the yield-per-recruit analysis performed here, selectivity was assumed to follow a logistic curve (i.e., changing with age) as opposed to knife-edge selection assumed in the Rachels and Ricks (2015) analysis, which assumes selectivity equivalent to zero until a pre-defined age at which selectivity is equal to one for that age and all older ages.

Per-recruit analyses do have the advantage of considering both growth overfishing and recruitment overfishing; however, another source of error and a disadvantage to using per-recruit approaches is that they do not account for differences in recruitment at varying stock abundance.

7 AGE COMPARISON

7.1 Introduction

Accurate age determination of fish is one of the most important elements to consider when conducting age structured stock assessments and is crucial information in estimating population parameters including recruitment, natural mortality, and growth.

Striped bass (*Morone saxatilis*) scales and otoliths have been collected sporadically by the North Carolina Division of Marine Fisheries (NCDMF) since 1975, although since 2003 both scales and otoliths have been collected routinely (Table 7.1). Since 1975, a total of 8,949 scale samples have been collected (primary ageing structure for striped bass), with roughly 8,518 collected between 2002 and 2018 (Table 7.1). Very few striped bass otoliths were collected before 2003, however since 2003, 2,122 otoliths have been collected by NCDMF (Table 7.1).

Beginning in 2010, a new genetics technique, termed parental based tagging (PBT), was implemented by the North Carolina Wildlife Resources Commission (NCWRC) to more accurately determine the percent hatchery contribution to striped bass populations in the Central Southern Management Area (CSMA). This method has proven to be greater than 99% accurate in determining if a fish was hatchery produced (Denson et al. 2012). In addition to determining hatchery contribution, PBT samples from hatchery produced fish identify the cohort or year class the striped bass was produced and consequently its age as each parent group is only used once. In 2016, the NCDMF started collecting striped bass fin clip samples for PBT analysis to determine percent hatchery contribution, and age of hatchery reared striped bass collected in the lower portions of CSMA rivers.

Though scale samples were collected by NCDMF from 1975 to 2001, very few striped bass were aged, and no striped bass were aged using scales from 2002–2017. To address the backlog of scale samples in anticipation of the 2017 stock assessment, all striped bass scales from 2002–2017 were processed to be aged.

In 2016, NCDMF began ageing the striped bass scales collected from 2002 to 2017, however concerns were quickly raised about the difficulty in interpreting CSMA striped bass scale annuli and disagreement between readers was high. Additionally, beginning in 2016 exact ages of stocked striped bass through PBT analysis became available.

7.2 Objectives

The objectives of this study were to: 1) determine and compare the accuracy and precision of scale ageing versus otolith ageing for CSMA striped bass, assuming genetic ages are true ages, and 2) to determine the difference in ageing-bias at each age and determine the precision among readers for each method using ages from scales and otoliths.

7.3 Methods

7.3.1 Preparation

7.3.1.1 **Scale Preparation**

To prepare scales for ageing, scale impressions were made on acetate sheets with a Carver© heated hydraulic laboratory press and annuli were counted by examination at 24x and 33x magnification on a microfiche reader. For a more detailed explanation of North Carolina Estuarine Striped Bass scale preparation and ageing protocol see the cooperative scale ageing document developed by NCWRC and NCDMF staff (NCWRC and NCDMF 2011).

7.3.1.2 **Otolith Preparation**

To prepare otoliths for ageing, a thin sectioning machine was used to section whole otoliths. The water-cooled, thin sectioning machine is equipped with two individual tools; a diamond blade cut-off saw and a precision diamond grinder. The precision grinder is fitted with a dial indicator gauge to control thickness and allows for varied section thicknesses. Both have guide arms for feeding slides to the blades.

Although left and right otoliths are collected, only one side is typically sectioned for ageing. Alternating between left and right otoliths for a species could lead to inconsistencies in the ageing process. The Ageing Lab at the NC Division of Marine Fisheries typically uses the left otolith for sectioning unless the left otolith was not collected or is of lower quality (e.g., crystalized, broken) than the right.

Otoliths are hand held and ground on the transverse plane adjacent to the focus. The purpose of sectioning is to remove both ends of the otolith leaving the transverse section containing the focus. The otolith is then mounted cut side down with the sulcal groove upward onto a frosted microscope slide using an ultra-violet (UV) cure adhesive, Loctite AA 349. After curing, the slides are placed on the guide-arm of the cut-off saw and guided past the saw to remove the bulk of the otolith. Slides are then placed onto the guide arm of the precision grinder and ground down by turning the guide arm adjuster gradually, starting at 1.0 mm thick and stopping at 0.5 mm thick for striped bass, and passing the sample on the guide-arm across the precision grinder.

Once the slides have been ground down, striped bass otolith sections are covered with a top coat. The top coat fills in the rough ground surface of the otolith section providing a clearer view of annuli. In a fume hood, a disposable pipette is used to apply enough Flo-Texx to entirely cover the sample. Adding this cover eliminates the need for polishing most samples.

7.3.1.3 **Genetic Sample Collection and Preparation**

A small piece of the pelvic fin was clipped from an individual striped bass and preserved in 95% ethyl alcohol for use in PBT analysis. The South Carolina Department of Natural Resources

(SCDNR) Population Genetics lab conducted microsatellite genotyping for individual fin clips, using a suite of 12 microsatellite markers for striped bass.

7.3.2 Age Determination

7.3.2.1 **Scale & Otolith Age Determination**

Scale and otolith annuli were counted to estimate age and assign a year-class. A minimum of two independent reads were required to age a fish and determine estimates of precision and accuracy. If both readers agreed on an age, that age was assigned to the fish. Discrepancies were resolved by readers sitting together and re-ageing the fish to assign a final age. If an agreement could not be reached, the sample was excluded from further analysis and not used in calculating the age agreement rate with known PBT ages.

7.3.2.2 **PBT Age Determination**

Since 2010, all broodstock used at the hatcheries to produce the stocked striped bass each year are genotyped (makeup of specific genes as passed on from ancestors). This is done each year, so a genetic record now exists of all the broodstock fish since 2010 used to produce striped bass that are stocked in CSMA rivers each year. This technique can only be applied to striped bass produced in the hatcheries since 2010. Therefore, year-classes produced before 2010 are of unknown origin via PBT. As of 2018, hatchery origin can be determined for all fish that are eight years of age and younger.

7.3.3 Comparison Analysis

7.3.3.1 **Objective 1**

In this analysis, a generalized linear mixed model (GLMM) was used to compare scale ageing versus the otolith ageing. In the model, ageing method was set as a fixed effect. The data included ages from scales (n=445; 2016–2017)), otoliths (n=126; 2016–2018), and genetics (PBT ages; n=513; 2016–2018) for the years 2016 through 2018 from 513 total striped bass. PBT ages ranged from one to seven. A total of five readers participated in ageing, among which all five readers read scale ages whereas only two readers read otolith ages. The response variable (Y) was the percentage ageing-bias relative to the genetic age (%):

$$Y = \text{(observed age – genetic age)/genetic age} * 100,$$

where observed age is either scale age or otolith age. During the ageing process, the same reader aged multiple fish. Thus, in the model, the reader was set as a random effect that assumed the percentage ageing-bias from the same reader was dependent while those from different readers were independent. This random effect represents the variability in percentage ageing-bias among readers, and thus it contributes to explaining the part of the variation that cannot be explained by the fixed effects. The GLMM was developed as follows:

$$Y_{gij} \sim Normal(\mu + \gamma_j + \alpha_i + \gamma_j * \alpha_i, \sigma_e^2)$$

where Y_{gij} is the percentage ageing-bias from fish $g = 1, \ldots, n$, reader $i = 1, \ldots, m$, and ageing method $j =$ {otolith ageing, scale ageing}; γ_j is the ageing method fixed effect, α_i is the reader random effect. An interaction term between reader and ageing method was included because a reader may be more proficient at one ageing method than the other. The fixed and random effects were modeled as:

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$$\alpha_i \sim Normal(0, \sigma_r^2)$$

with priors;

$\mu \sim Normal(0, 100)$, $\gamma_j \sim Normal(0, 100)$,

$\sigma_r^2 \sim Gamma(0.1, 0.1)$, $\sigma_e^2 \sim Gamma(0.1, 0.1)$

The total variance was $Var(Y_{ij}) = \sigma_e^2 + \sigma_r^2$. The relative contribution of reader and error variance are given as the posterior summaries for random error and reader random effects is as follows:

$p_e = \frac{\sigma_e^2}{\sigma_e^2+\sigma_r^2}$ $p_r = \frac{\sigma_r^2}{\sigma_e^2+\sigma_r^2}$

The analysis was modeled in a Bayesian framework using JAGS version 4.30 (Plummer 2003) in RStudio version 3.6.0 (R Core Team 2013) with 200,000 iterations, three separate chains, a 20,000 iteration burn-in, and thinning set to ten. Convergence was verified by visual inspection of chain trace plots and Rhat values of 1.03 or less.

7.3.3.2 **Objective 2**

Statistical analyses were done using a symmetric test (Hoenig et al. 1995) and coefficient of variation (CV) analysis to determine bias and precision. The data included ages from scales (n=3,611; 2002–2017) and otoliths (n=1,890; 2003–2018) for the years 2002 through 2018 for 4,604 striped bass. Ages ranged from one through 16. Ages were read by seven readers in total and scales were read by all seven readers whereas otoliths were read by only two of the readers. Tests were done for the following comparisons: (1) between otolith and scale ages; (2) between scale readers; and (3) between otolith readers.

7.4 Results

7.4.1 Objective 1

Preliminary investigation to understand the underlying relationships that explain the variability in the data indicated that the reader identification (ID) might be an important variable (Figure 7.1, Table 7.2) as well as method type (Figure 7.2). The summary statistics from the raw data (Table 7.2) indicated that readers 1 and 2 demonstrated differences in accuracy and precision dependent on the method type. Reader 1 had similar accuracy for both method types but with higher variability for scale ages with mean age bias for otolith ages of -0.899% (sd=8.45) and for scale ages of -0.0935% (sd=15.2); however, reader 2 had very different levels of accuracy and precision between methods with a mean age bias for otolith ages of -1.81% (sd=7.25) and for scale ages of 23.1% (sd=22.3). This demonstrates a need to account for the interaction between reader and method type.

Some ages may be more likely to be underestimated or overestimated than other ages thus, the genetic age of the fish was also initially considered as a possible variable that may affect ageing accuracy and precision (Figure 7.3). However, since the genetic ages were used in the calculation of the response variable, there was an inherent correlation between these values and thus, genetic age was not used in the analysis.

The results demonstrated differences in accuracy and precision due to reader ID (Table 7.3, Figure 7.4) with readers 1, 3, and 4 tending to slightly underestimate age with low variability indicated by the posterior medians of -0.858% (sd=0.274), -0.931% (sd=0.291), and -1.00% (sd=0.302), respectively. Readers 2 and 5 tended to overestimate with higher variability as shown by the posterior medians of 2.47% (sd=2.48) and 0.280% (sd=0.916), respectively. The posterior median of standard deviation from reader effects was 1.67 (sd=1.46). Reader effects explained 1.7% (sd=4.0) of the total variability in data. The ageing method results (Table 7.3, Figure 7.4) showed that ages from scales tended to overestimate age with a posterior median of 7.90% (sd=3.90, 95% conf. interval=1.37 to 16.6) and ages from otoliths were unbiased with much higher precision than scales demonstrated by the posterior median of -1.19% (sd=0.82, 95% conf. interval=-2.88 to 0.51). The random error standard deviation posterior median was 15.5 (sd=0.261) and accounted for the remaining 98.3% (sd=4.0) of the total variability.

7.4.2 Objective 2

The comparison between scales and otoliths (Figure 7.5) indicate agreement of 50.7% with a CV of 5.4% ($\chi^2=1373.2$, *df*=64, P<0.01). The percentage age-bias plot (Figure 7.6) demonstrates that scales compared to otoliths tended to overestimate ages less than 5 and underestimate ages greater than 5. There was no difference between otolith readers with a CV of 2.2% ($\chi^2=35.6$, *df*=34, P=0.392); however, the results from the between reader comparisons for scale ages (Table 7.4) indicate that 11 out of the 13 unique reader combinations were significantly different with CVs ranging from 2.5% to 7.0% and percent agreements ranging from 19% to 88%.

7.5 Discussion

7.5.1 Objective 1

This analysis demonstrates the importance of understanding and accounting for differences among readers and the interaction between the method type and reader ID to accurately assess the potential bias and level of precision in ageing striped bass. The results from this analysis indicate that scale ageing was biased with comparatively low precision whereas, otolith ageing was unbiased with a higher level of precision. These results are in agreement with previous research where ages from otoliths were significantly different than ages from scales (Secor et al. 1995; Liao et al. 2009). Furthermore, they agree with results from Liao et al. (2013) where known ages were compared with ages from both otoliths and scales and otoliths were found to have much smaller error than scales.

7.5.2 Objective 2

The results from this analysis agree with the Bayesian GLMM analysis demonstrating significant differences in ages from otoliths compared to ages from scales. In both analyses, the precision between otolith readers was much higher than for scale readers indicating scale ages have higher uncertainty associated with them. Moreover, the results from this analysis also agree with prior research where scale ages from older fish tend to be underestimated and younger fish tend to be overestimated (Secor et al. 1995; Liao et al. 2009; Liao et al. 2013). The reason for the overestimation of younger ages is likely due to false annuli being mistaken for true annuli and older ages are underestimated due to the slenderness of tightly packed annuli on the periphery of the scales (Secor et al. 1995; Liao et al. 2013).

7.6 Conclusion

Estimating striped bass age with scales is a common practice and the preferred method for anadromous striped bass on the Atlantic Coast (ASMFC 2003). Scales are relatively easy to collect in the field and striped bass may be released alive after structure collection. In addition, scales may be collected with negligible effect on striped bass intended for market. However, Liao et al. (2013) found that scales overestimated ages of young fish and underestimated ages of old fish. Studies by Welch et al. (1993) and Secor et al. (1995) also indicate scales tend to underestimate the actual age of older fish beginning at age 10 when compared to otoliths. Biases in age estimates impact catch-at-age data and estimates of recruitment, natural mortality and growth.

Unlike most studies, due to PBT analysis, known-age samples from striped bass are now available and allow for validation of scale and otolith ages. A comparison of scale and otolith ages collected from striped bass in the Chesapeake Bay found otoliths provided more accurate and precise estimates of ages than scales when compared to known age fish (Liao et al. 2013). The current study similarly shows otoliths provide a more precise and accurate age estimate for CSMA striped bass when compared to scales.

This research has important implications regarding the use of ages from scales and otoliths for the management of striped bass populations. Age bias and imprecision can have significant effects on estimates of growth parameters used in stock assessment modeling (either estimated outside of the assessment model or within an integrated assessment model). Previous research has demonstrated that population dynamics estimates and biological reference points used for management are sensitive to the misspecification (bias) in growth parameter estimates (Zhu et al. 2016). Liao et al. (2013) demonstrated that age bias can adversely affect catch-at-age models by reducing the ability to track the progression of year classes caused by incorrectly assigning fish to appropriate cohorts resulting in strong recruitment events appearing weaker thus resulting in a subsequent reduction in recruitment variability. Liao et al. (2013) suggest the inability to track recruitment signals would prolong recovery of a depleted stock and result in an unnecessarily restricted harvest after recovery had occurred.

7.7 Recommendation

The NCDMF recommends that otoliths should be used by both agencies to age CSMA striped bass if PBT ages are not available, and a power analysis should be conducted to determine sample sizes needed for determining the representative age structure. Another recommendation is conduct a similar study across NCDMF and NCWRC biologists to determine and compare the accuracy and precision of scale ageing versus otolith ageing for the Albemarle Sound and Roanoke River striped bass management areas.

8 RESEARCH RECOMMENDATIONS

The research recommendations listed below (in no particular order) are intended to improve future assessments of the CSMA striped bass stocks. The bulleted items outline the specific issue and are organized by priority ranking.

High

- Acquire life history information: maturity, fecundity, size and weight at age, egg and larval survival (ongoing through CRFL funded projects and NCDMF P930 data collection; see Knight, 2015, for recent work on maturation and fecundity in the Neuse and Tar-Pamlico rivers)
- Conduct delayed mortality studies for recreational and commercial gear during all seasons factoring in relationships between salinity, dissolved oxygen, and water temperature
- Develop better estimates of life-history parameters, especially growth and factors influencing rates of natural mortality for all striped bass life stages (growth is ongoing through NCDMF P930 data collection; for natural mortality, see recent publications Bradley 2016 and Bradley et al. 2018b)

Medium

- Determine factors impacting survivability of stocked fish in each system (Bradley et al. 2018b)
- Implement a random component to NCDMF program 100 juvenile sampling in the CSMA
- Conduct a power analysis to determine minimum sample sizes needed for determining the representative age structure

Low

- Determine if contaminants are present in striped bass habitats and identify those that are potentially detrimental to various life history stages (ongoing through N.C. Division of Water Quality but could be expanded; in 2017, NCSU was awarded a CRFL grant to conduct research on striped bass eggs, including evaluating for Gen X)
- Identify minimum flow requirements in the Tar-Pamlico, Neuse, and Cape Fear rivers necessary for successful spawning, egg development, and larval transport to nursery grounds
- Evaluate factors influencing catchability of striped bass, particularly larger striped bass, in electrofishing surveys conducted on the spawning grounds
- Obtain improved commercial discard estimates from the estuarine gill-net fisheries (i.e., anchored, runaround, and strike gill nets) in the CSMA systems to better characterize harvest and discards
- Investigate factors influencing mixing rates between A-R and CSMA striped bass stocks
- Identify water quality parameters that impact spawning, hatching, and survival of striped bass in CSMA systems
- Develop a consistent ageing approach across agency sampling programs
- Continue PIT tagging striped bass in the Cape Fear River and expand PIT tagging to the Tar-Pamlico and Neuse rivers to estimates of spawning population size
- Investigate factors influencing rates of natural mortality for all striped bass life stages in the CSMA systems

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10 TABLES

Table 1.1. Stocking numbers of Phase II (5–7 inches total length) striped bass by system and year for the Tar-Pamlico, Neuse, and Cape Fear rivers, 1980–2018.

Year Class	Tar-Pamlico River	Neuse River	Cape Fear River
1980			14,874
1981		47,648	
1982	76,674		
1983			
1984	26,000		56,437
1985		39,769	
1986			
1987	17,993		
1988		71,092	
1989			77,242
1990		61,877	
1991	30,801		
1992		116,820	
1993	118,600		
1994	183,254	79,933	
1995	140,972		
1996		100,760	
1997	24,031		
1998		83,195	
1999	17,954		
2000		108,000	
2001	37,000		
2002		147,654	
2003	159,996		
2004		168,011	172,055
2005	267,376		
2006		99,595	102,283
2007	69,871	69,953	
2008	91,962		92,580
2009	61,054	104,061	112,674

Table 1.1. (*continued*) Stocking numbers of Phase II (5–7 inches total length) striped bass by system and year for the Tar-Pamlico, Neuse, and Cape Fear rivers, 1980–2018.

Year Class	Tar-Pamlico River	Neuse River	Cape Fear River
2010[1]	114,012	107,142	210,105
2011	107,767	102,089	130,665
2012[2]	45,667	90,178	127,078
2013	123,416	113,834	195,882
2014	92,727	78,899	141,752
2015	52,922	109,146	116,011
2016	121,190	134,559	63,914
2017	101,987	14,203[3]	154,024
2018	186,609	149,076	152,593

[1] First year of *in situ* broodstock collection from the Cape Fear River
[2] First year of *in situ* broodstock collection form the Tar-Pamlico and Neuse rivers
[3] Poor spawning of broodstock led to low stocking numbers

Table 1.2. Percent hatchery contribution from striped bass genetic samples collected in the Tar-Pamlico, Neuse, and Cape Fear rivers by NCDMF and NCWRC staff, 2013–2018. (Source: South Carolina Department of Natural Resources)

Year	Agency	System	n Total	n Hatchery	n Unknown	% Hatchery	% Unknown
2013	NCWRC	Upper Tar-Pamlico	196	162	34	83	17
		Upper Neuse	195	130	65	67	33
		Cape Fear	219	138	81	63	37
2014	NCWRC	Upper Tar-Pamlico	205	174	31	85	15
		Upper Neuse	299	247	52	83	17
		Cape Fear	292	223	71	76	24
2015	NCWRC	Upper Tar-Pamlico	208	194	14	93	7
		Upper Neuse	241	176	65	73	27
		Cape Fear	233	166	67	71	29
2016	NCDMF	Tar-Pamlico	190	164	26	86	14
		Neuse	150	142	8	95	5
		Cape Fear					
	NCWRC	Upper Tar-Pamlico	195	171	24	88	12
		Upper Neuse	61	44	17	72	28
		Cape Fear	213	196	17	92	8
2017	NCDMF	Tar-Pamlico	147	102	45	70	31
		Neuse	118	66	52	56	44
		Cape Fear	110	93	17	85	15
	NCWRC	Upper Tar-Pamlico	137	96	41	70	30
		Upper Neuse	233	198	35	85	15
		Cape Fear	119	106	13	89	11
2018	NCDMF	Tar-Pamlico	206	74	132	36	64
		Neuse	86	46	40	54	47
		Cape Fear	96	81	15	84	16
	NCWRC	Upper Tar-Pamlico	166	67	99	41	59
		Upper Neuse	322	250	72	78	12
		Cape Fear	119	110	9	93	7

Table 2.1. Summary (mean, minimum, maximum and number of samples) striped bass length data (TL in inches) from CSMA commercial harvest, 2000–2018.

	Tar-Pamlico R. / Pungo R.				Neuse / Bay R.			
Year	**Mean**	**Min**	**Max**	**n**	**Mean**	**Min**	**Max**	**n**
2000	23	20	35	126	25	22	31	5
2001	23	21	26	116	25	23	31	12
2002	24	19	39	96	25	19	29	31
2003	23	18	37	173	24	19	37	19
2004	24	20	42	131	25	19	37	74
2005	23	20	37	127	24	20	36	70
2006	22	18	37	119	24	19	36	144
2007	22	19	33	112	22	19	27	63
2008	22	18	43	84	23	19	44	39
2009	22	19	31	99	22	18	31	85
2010	22	19	26	194	23	19	32	263
2011	23	18	27	284	23	19	42	195
2012	24	15	30	254	24	19	29	96
2013	25	18	40	225	25	18	39	301
2014	22	18	39	52	24	20	38	56
2015	24	19	40	97	24	19	44	97
2016	24	17	29	257	23	19	28	78
2017	24	19	31	151	24	19	50	97
2018	23	19	32	76	24	18	38	163

Table 2.2. Commercial estimates of striped bass discards (standard error in parentheses) in the Tar-Pamlico/Pungo rivers by mesh size, 2013–2018.

Year	Live Releases			Dead			Release Mortalities		Total Dead	
	Small Mesh	Large Mesh	Combined	Small Mesh	Large Mesh	Combined	Small Mesh	Large Mesh	Small Mesh	Large Mesh
2013	484 (123)	490 (150)	975 (244)	59 (13)	230 (73)	289 (85)	208	211	267	442
2014	258 (83)	490 (133)	749 (143)	33 (11)	233 (80)	266 (91)	112	212	145	445
2015	149 (46)	145 (51)	296 (87)	41 (15)	184 (75)	224 (90)	65	63	106	246
2016	421 (97)	470 (171)	891 (242)	30 (11)	131 (36)	161 (46)	181	203	210	333
2017	269 (104)	143 (64)	411 (159)	37 (13)	93 (38)	130 (51)	115	60	152	154
2018	416 (214)	346 (145)	762 (344)	25 (7)	86 (30)	111 (36)	179	148	204	234

Table 2.3. Commercial estimates of striped bass discards (standard error in parentheses) in the Neuse/Bay rivers by mesh size, 2013–2018.

Year	Live Releases			Dead			Release Mortalities		Total Dead	
	Small Mesh	Large Mesh	Combined	Small Mesh	Large Mesh	Combined	Small Mesh	Large Mesh	Small Mesh	Large Mesh
2013	110 (32)	132 (45)	243 (69)	34 (8)	204 (53)	237 (61)	47	58	81	261
2014	182 (61)	74 (22)	256 (76)	54 (20)	108 (35)	162 (54)	78	32	133	139
2015	56 (20)	14 (6)	71 (25)	45 (17)	68 (27)	112 (43)	23	7	68	74
2016	57 (14)	91 (36)	149 (47)	10 (3)	88 (25)	98 (28)	25	39	36	127
2017	51 (22)	35 (17)	86 (37)	20 (7)	81 (31)	101 (38)	21	15	44	96
2018	180 (96)	117 (48)	297 (138)	29 (8)	96 (29)	124 (37)	78	51	107	145

Table 2.4. Recreational effort, harvest, and discards estimates for striped bass in the Tar-Pamlico, Pungo, Neuse, and Cape Fear rivers and tributaries.

		Recreational Fishing Effort				Recreational Harvest		Striped Bass Discards				
Zone	**Year**	**Total Angler Fishing Trips**	**Total Fishing Effort (Angler Hours)**	**Striped Bass Angler Trips**	**Striped Bass Effort (Angler Hours)**	**numbers**	**pounds**	**n over creel**	**n undersized**	**n legal sized**	**n slot sized**	**Total**
Neuse River	**2004**	26,663	162,424	7,445	39,942	3,985	14,845	29	5,721	1,221	0	6,971
	2005	64,301	249,396	9,678	42,107	1,641	6,540	13	6,473	630	77	7,193
	2006	39,181	162,559	6,260	24,053	1,244	4,079		7,797	1979	0	9,776
	2007	31,052	142,093	4,965	20,966	2,616	7,115	140	4,858	1,484	0	6,482
	2008	28,134	136,575	3,174	12,954	405	1,510	2,838	4,801	2,450	51	10,140
	2009	17,519	77,634	2,474	12,995	249	868		443	704	138	1,285
	2010	19,540	83,108	2,340	9,177	109	361		699	1,440	13	2,152
	2011	24,407	97,302	5,657	21,393	1,080	3,809		7,426	2,434	913	10,773
	2012	70,649	210,197	8,703	34,652	1,508	5,742	334	13,660	9,741	664	24,400
	2013	62,013	201,924	10,433	45,068	2,563	9,604	312	6,709	3,286	1,191	11,498
	2014	56,805	213,867	7,840	35,829	1,230	5,603	0	5,810	3,050	1,044	9,903
	2015	56,636	250,634	6,515	27,747	1,373	4,804	0	4,904	3,184	387	8,476
	2016	49,869	210,111	7,107	30,422	1,506	5,619	0	10,788	3,599	2,189	16,575
	2017	60,899	270,485	10,450	50,648	3,188	12,337	519	27,870	16,343	1,479	46,210
	2018	45,237	160,827	6,076	26,228	965	3,090	17	3,459	7,296	986	11,758
	Total	**652,905**	**2,629,136**	**99,117**	**434,181**	**23,661**	**85,926**	**4,202**	**111,419**	**58,841**	**9,132**	**183,593**

Table 2.4. (***continued***) Recreational effort, harvest, and discards estimates for striped bass in the Tar-Pamlico, Pungo, Neuse, and Cape Fear rivers and tributaries.

		Recreational Fishing Effort				Recreational Harvest		Striped Bass Discards				
Zone	**Year**	**Total Angler Fishing Trips**	**Total Fishing Effort (Angler Hours)**	**Striped Bass Angler Trips**	**Striped Bass Effort (Angler Hours)**	**numbers**	**pounds**	**n over creel**	**n undersized**	**n legal sized**	**n slot sized**	**Total**
Tar-Pamlico River	**2004**	13,880	74,984	3,427	13,666	663	2,886	0	3,465	263	0	3,728
	2005	18,334	68,588	4,662	17,668	572	2,511	0	8,423	310	0	8,733
	2006	15,012	72,475	2,964	12,297	675	1,442	0	2,588	278	0	2,866
	2007	21,623	102,968	4,144	17,001	346	1,655	0	12,393	114	0	12,507
	2008	11,521	59,030	2,899	13,283	175	647	0	5,138	295	37	5,470
	2009	15,298	68,715	2,412	10,474	233	794	0	2,347	512	288	3,147
	2010	12,008	52,227	3,913	15,102	1,510	4,696	22	3,925	843	338	5,128
	2011	15,260	60,509	6,209	26,258	1,234	4,253	9	8,062	2,687	1,124	11,882
	2012	30,626	109,560	8,936	34,027	2,049	8,221	17	10,298	3,480	2,246	16,040
	2013	39,446	137,943	8,811	35,645	2,108	7,289	134	10,311	6,401	1,090	17,937
	2014	22,514	89,749	6,945	30,131	1,898	7,163	728	12,793	2,052	531	16,105
	2015	38,513	147,296	10,724	47,305	2,147	8,082	40	12,329	4,566	426	17,361
	2016	46,700	199,478	14,909	72,897	4,861	18,502	203	29,089	5,844	4,544	39,680
	2017	48,876	182,534	14,636	63,843	3,495	12,566	0	51,334	9,522	803	61,659
	2018	34,648	130,200	9,274	38,548	2,046	6,403	854	22,366	4,028	904	28,151
	Total	**384,259**	**1,556,255**	**104,865**	**448,144**	**24,011**	**87,110**	**2,008**	**194,861**	**41,195**	**12,331**	**250,395**
Pungo River	**2004**	5,532	40,573	1,910	10,183	1,493	5,227	56	2,543	259	0	2,858
	2005	7,029	34,386	2,074	9,595	1,619	5,914	139	713	76	0	928
	2006	8,470	44,599	1,387	5,716	562	1,831	33	2,163	57	0	2,253
	2007	13,089	64,273	1,862	8,688	635	2,024	7	4,422	109	0	4,538
	2008	13,232	71,210	548	2,176	263	833	0	1,782	571	3	2,356

Table 2.4. (*continued*) Recreational effort, harvest, and discards estimates for striped bass in the Tar-Pamlico, Pungo, Neuse, and Cape Fear rivers and tributaries.

		Recreational Fishing Effort				Recreational Harvest		Striped Bass Discards				
Zone	Year	Total Angler Fishing Trips	Total Fishing Effort (Angler Hours)	Striped Bass Angler Trips	Striped Bass Effort (Angler Hours)	numbers	pounds	n over creel	n undersized	n legal sized	n slot sized	Total
Pungo River	**2009**	13,090	67,410	756	3,142	413	1,399	7	1,681	553	292	2,533
	2010	5,970	29,308	306	1,075	138	480	7	576	118	9	710
	2011	5,579	27,996	740	3,889	414	1,412	0	1,171	276	86	1,533
	2012	9,415	50,264	700	3,285	365	1,277	88	2,385	400	0	2,873
	2013	12,665	69,902	892	5,336	796	2,644	0	2,282	669	75	3,026
	2014	7,440	44,458	459	2,192	173	602	0	582	2,002	66	2,650
	2015	5,767	32,743	711	3,644	414	1,383	0	5,038	279	0	5,317
	2016	8,806	46,520	1,268	5,670	330	1,139	0	17,997	534	46	18,578
	2017	14,534	81,889	1,013	5,031	652	2,070	31	22,582	622	11	23,246
	2018	10,785	66,683	1,019	5,080	360	1,391	0	8,304	768	0	9,072
	Total	**141,401**	**772,215**	**15,645**	**74,703**	**8,627**	**29,626**	**368**	**74,221**	**7,293**	**589**	**82,471**
Cape Fear River	**2013**	22,251	103,412	257	870	0	0	92	0	263	0	355
	2014	6,931	28,622	438	2,164	0	0	721	0	830	0	1,551
	2015	9,056	55,463	209	702	0	0	176	0	22	0	199
	2016	9,936	43,226	391	1,464	0	0	12	0	616	0	628
	2017	2,159	11,057	26	159	0	0	0	0	14	0	14
	2018	6,062	24,568	24	61	0	0	0	0	140	0	140
	Total	**50,332**	**241,780**	**1,345**	**5,419**	**0**	**0**	**1,001**	**0**	**1,885**	**0**	**2,886**

Table 2.4. (***continued***) Recreational effort, harvest, and discards estimates for striped bass in the Tar-Pamlico, Pungo, Neuse, and Cape Fear rivers and tributaries.

		Recreational Fishing Effort				Recreational Harvest		Striped Bass Discards				
Zone	**Year**	**Total Angler Fishing Trips**	**Total Fishing Effort (Angler Hours)**	**Striped Bass Angler Trips**	**Striped Bass Effort (Angler Hours)**	**numbers**	**pounds**	**n over creel**	**n undersized**	**n legal sized**	**n slot sized**	**Total**
All CSMA	**2004**	46,075	277,981	12,782	63,791	6,141	22,958	85	11,729	1,743	0	13,557
	2005	89,664	352,370	16,414	69,370	3,832	14,965	152	15,609	1,016	77	16,854
	2006	62,663	279,633	10,611	42,066	2,481	7,352	33	12,548	2,314	0	14,895
	2007	65,764	309,334	10,971	46,655	3,597	10,794	147	21,673	1,707	0	23,527
	2008	52,887	266,815	6,621	28,413	843	2,990	2,838	11,721	3,316	91	17,966
	2009	45,907	213,759	5,642	26,611	895	3,061	7	4,471	1,769	718	6,965
	2010	37,518	164,643	6,559	25,354	1,757	5,537	29	5,200	2,401	360	7,990
	2011	45,246	185,807	12,606	51,540	2,728	9,474	9	16,659	5,397	2,123	24,188
	2012	110,689	370,021	18,338	71,964	3,922	15,240	439	26,343	13,621	2,910	43,313
	2013	136,374	513,181	20,394	86,918	5,467	19,537	539	19,302	10,619	2,357	32,816
	2014	93,690	376,696	15,682	70,316	3,301	13,368	1,449	19,185	7,934	1,641	30,209
	2015	109,972	486,136	18,159	79,398	3,934	14,269	217	22,272	8,052	813	31,353
	2016	115,311	499,335	23,675	110,453	6,697	25,260	215	57,874	10,593	6,779	75,461
	2017	126,467	545,965	26,125	119,680	7,334	26,973	549	101,787	26,501	2,293	131,129
	2018	96,732	382,278	16,393	69,917	3,371	10,884	871	34,128	12,232	1,890	49,122
	Total	**1,228,898**	**5,199,385**	**220,972**	**962,447**	**56,299**	**202,662**	**7,579**	**380,500**	**109,215**	**22,052**	**519,345**

Table 2.5. Annual weighted relative abundance index of striped bass (number of individuals per sample), total number of striped bass collected, and the number of gill net samples (n) in the Tar-Pamlico, Pungo, and Neuse rivers (2004–2018) and the Cape Fear and New rivers (2008–2018). The Percent Standard Error (PSE) represents a measure of precision of the index.

	Tar-Pamlico and Pungo rivers				Neuse River				Cape Fear and New rivers[4]			
Year	**Index**	**n Striped Bass**	**n samples**	**PSE [Index]**	**Index**	**n Striped Bass**	**n samples**	**PSE [Index]**	**Index**	**n Striped Bass**	**n samples**	**PSE [Index]**
2004	1.2	184	160	16	1.04	158	160	26				
2005	2.66	396	152*	14	1.37	200	152[5]	23				
2006	2.38	371	160	17	1.74	268	160	17				
2007	1.57	241	160	22	1.16	177	160	19				
2008	1.61	249	160	21	1.25	193	161	23	0.04	3	84	100
2009	1.18	182	160	16	0.9	142	160	26	0.03	3	119	67
2010	2.11	329	160	17	2.02	311	160	23	0.01	1	120	100
2011	2.15	328	160	20	2.14	325	160	18	0.04	4	120	50
2012	0.94	143	160	20	0.84	127	160	20	0.03	3	120	67
2013	1.41	215	160	18	0.98	149	160	24	0.02	2	120	50
2014	1.43	217	160	16	1.82	273	160	20	0	0	120	
2015	1.14	173	160	18	1.65	251	160	18	0.14	15	120	36
2016	1.16	178	160	14	1.17	178	160	14	0.11	12	120	45
2017	1.21	186	160	17	1.41	218	160	16	0.08	9	120	50
2018	2.26	346	160	21	1.34	204	160	19	0.03	3	113	67

[4] Sampling in the Cape Fear and New rivers began in 2008
[5] In 2005, fewer stations were sampled due to high gasoline prices

Table 2.6. NCWRC annual catch summary for the Tar River striped bass electrofishing survey, 1996–2018.

Year	n Sample Events	Total Catch	Males	Females	Effort	Mean Index	SD [Index]	SE [Index]	Peak Index
1996	3	535	373	162	98,640	19.5	0.6	0.4	20.3
1997	3	1,275	1,045	230	103,572	44.3	13.7	7.9	53.1
1998	14	1,061	897	164	91,263	41.6	30.8	8.2	97.3
1999	8	561	334	227	50,793	36.7	28.7	10.1	93.7
2000	9	547	348	199	41,443	51.8	37.7	12.6	132.1
2001	6	326	240	86	24,814	46.8	15	6.1	68
2002	7	369	260	109	40,798	35.2	23.4	8.8	68.4
2003	6	211	169	42	23,862	31.1	13.8	5.6	51.7
2004	7	318	225	93	32,401	36.3	11.6	4.4	51
2005	13	1,429	1,390	39	63,456	86.9	53.1	14.7	184.9
2006	7	530	437	93	35,300	55.1	18.6	7	82.2
2007	8	317	264	53	41,019	29	12.2	4.3	43.5
2008	10	505	469	36	42,564	43.4	35.3	11.2	116.8
2009	6	347	265	82	23,532	48.1	33.6	13.7	98.3
2010	4	392	313	79	12,600	99.8	81.1	40.6	200
2011	4	202	100	102	18,800	37.1	19.8	9.9	54.7
2012	7	249	195	54	33,630	29.7	24.6	9.3	71.6
2013	7	315	241	74	32,400	34.2	13.5	5.1	44.7
2014	9	339	243	96	43,200	27	15.9	5.3	58.7
2015	11	418	354	64	46,800	35.1	21.9	6.6	90
2016	12	286	247	39	36,000	27.3	14.7	4.2	52
2017	5	180	128	49	23,400	25.5	9.9	4.4	34.7
2018	16	221	166	48	45,000	18.2	20.1	5	80

Table 2.7. NCWRC annual catch summary for the Neuse River striped bass electrofishing survey, 1994–2018.

Year	n Sample Events	Total Catch	Males	Females	Effort	Mean Index	SD [Index]	SE [Index]	Peak Index
1994	5	121	92	28	26,452	18.7	10.5	4.7	29.7
1995	5	125	107	18	26,381	15.3	13.2	6.6	33.2
1996	24	226	168	58	69,489	10	16.1	3.3	48
1997	26	143	114	29	76,537	6	7.1	1.4	20.8
1998	21	219	176	43	61,125	11.9	15.6	3.4	44
1999	15	292	242	50	49,562	20.4	15.6	4	62
2000	24	352	241	111	67,449	18.4	19.2	3.9	66.7
2001	22	155	132	23	57,680	8.6	11.2	2.4	46.6
2002	22	100	82	18	68,340	5.1	4.9	1	21
2003	40	401	303	98	112,305	11.8	17.6	2.8	90.5
2004	14	73	54	19	40,858	6.5	3.6	1	12.6
2005	14	65	56	9	51,094	4.5	6.6	1.8	24
2006	15	58	53	5	36,528	6.8	12.2	3.1	43.7
2007	23	170	138	32	62,372	9.8	11	2.3	51.2
2008	23	138	107	31	81,116	4.4	4.4	0.9	16.6
2009	18	360	328	31	59,094	14.1	18.1	4.3	57.3
2010	17	141	122	19	52,116	10	12.6	3.1	44.4
2011	19	176	115	60	54,129	13.9	12.4	2.8	38.4
2012	28	144	116	27	63,468	8.9	15.5	2.9	66.6
2013	29	322	265	56	71,490	15	12.4	2.3	53.7
2014	39	284	201	83	91,120	10.1	14.7	2.3	71.6
2015	42	226	198	28	47,560	15.5	27.6	4.3	137.4
2016	42	93	71	22	45,579	7.4	6.6	1	29.5
2017	61	200	155	45	81,692	6.7	11.2	1.4	55.8
2018	56	282	236	46	77,132	12.5	11.5	1.5	44.1

Table 2.8. NCWRC annual catch summary for the Cape Fear River striped bass electrofishing survey, 2003–2018.

Year	n Sample Events	Effort	n Females	n Males	Total Catch	Mean Index	SD [Index]	SE [Index]	Peak Index
2003	11	18,562	12	4	16	4.5	5.5	1.7	14
2004	8	8,843	20	17	42	25.4	20.1	7.1	57.8
2005	20	61,200	35	42	103	6.5	7.3	1.6	26
2006	12	25,429	2	2	5	1	1.9	0.5	5.8
2007	22	46,557	28	30	120	10.8	15.6	3.3	60
2008	21	45,900	35	64	100	8.8	11.2	2.5	38
2009	21	44,677	27	57	103	9.2	8.3	1.8	24
2010	24	43,200	110	62	182	15.2	13.7	2.8	56
2011	24	42,300	59	37	105	9	12.3	2.5	54
2012	26	45,521	64	55	119	9.2	10	2	30
2013	23	41,400	28	65	99	8.6	14.7	3.1	52
2014	24	43,123	30	71	154	12.9	15.7	3.2	55.6
2015	20	36,259	78	102	193	19.1	27.9	6.2	104
2016	25	45,408	45	145	202	15.9	28.7	5.7	102
2017	19	34,036	47	59	107	11.3	24.7	5.7	86
2018	15	27,315	20	28	58	7.7	6.8	1.7	23.8

Table 1.9. Total number of striped bass PIT tagged by all gears and tagger affiliation in the Cape Fear River, 2011–2018.

Tagger	Gear	2011	2012	2013	2014	2015	2016	2017	2018	All
NCDMF	Electrofisher	133	235	336	410	484	388	262	342	2,590
	Gill Net (P915)	11			2	4	3	4		24
	Gill Net (run-around)	9				3	2	6		20
	Hook and line	23	8		8	9	14	11		73
	Trotline			1						1
NCWRC	Electrofisher	72	88	50	99	154	128	33	33	657
Tournament	Hook and line	16	21	38	31	20	33	34	17	210
Volunteer	Hook and line	21	42	34	45	10	24	9		185
All	All	285	394	459	595	684	592	359	392	3,760

Table 2.10. Total number of striped bass PIT tagged by gear and tagger affiliation included in the tagging model in the Cape Fear River, 2012–2018.

Tagger	Gear	2012	2013	2014	2015	2016	2017	2018	All
NCDMF	Electrofisher	235	336	410	484	388	262	342	2,457
	Hook and line	8		8	9	14	11		50
NCWRC	Electrofisher	88	50	99	154	128	33	33	585
Tournament	Hook and line	21	38	31	20	33	34	17	194
Volunteer	Hook and line	42	34	45	10	24	9		164
All	All	394	458	593	677	587	349	392	3,450

Table 2.11. Mean, standard deviation (SD), minimum, and maximum total length (TL) of striped bass tagged by year, gear, and tagger affiliation included in the tagging model for the Cape Fear River, 2012–2018.

Group	Level	n	Mean TL (mm)	SD [Mean TL]	Minimum TL (mm)	Maximum TL (mm)
Year	2012	394	544.6	118.2	219	846
	2013	458	534.3	109	192	835
	2014	593	540.8	119.2	212	800
	2015	677	508.5	128.9	284	891
	2016	586	525.7	101.8	329	889
	2017	349	540.4	103.4	298	867
	2018	392	569	101.4	337	809
Gear	Hook and line	408	557.8	115.4	330	838
	Electrofishing	3,041	531.5	114.4	192	891
Tagger	NCDMF	2,507	525.2	114.5	219	867
	NCWRC	584	558.7	109.1	192	891
	Tournament	194	537	110.7	330	823
	Volunteer	164	590.7	116.3	355	838

Table 2.12. Total number of striped bass PIT tag recaptures by all gears in the Cape Fear River, 2011–2018.

Year	Tagged	Recapture Year								Total	Percent
		2011	2012	2013	2014	2015	2016	2017	2018	Recaptured	Recaptured
2011	285	6	8	10	3	2	4	.	.	33	11.6
2012	394	.	4	14	12	6	.	.	1	37	9.4
2013	459	.	.	18	14	9	8	3	3	55	12
2014	595	.	.	.	14	23	5	3	4	49	8.2
2015	684	.	.	.	.	9	8	11	2	30	4.4
2016	592	.	.	.	.	.	10	15	7	32	5.4
2017	359	.	.	.	.	.	.	7	11	18	5
2018	392	.	.	.	.	.	.	.	5	5	1.3
All	3,760	6	12	42	43	49	35	39	33	259	6.9

Table 2.13. Total number of striped bass PIT tag recaptures, from electrofishing gear, included in the tagging model for the Cape Fear River, 2012–2018.

Year	Tagged	Recapture Year							Total Recaptured	Percent Recaptured
		2012	2013	2014	2015	2016	2017	2018		
2012	394	4	14	12	5	.	.	1	36	9.1
2013	458	.	18	14	8	8	3	3	54	11.8
2014	593	.	.	14	21	5	3	4	47	7.9
2015	677	.	.	.	9	7	11	2	29	4.3
2016	587	.		.	.	10	15	7	32	5.5
2017	349	.	.	.	.	.	7	11	18	5.2
2018	392	.	.	.	.	.	.	5	5	1.3
All	3,450	4	32	40	43	30	39	33	221	6.4

Table 2.14. Distance (miles) between release and recapture sites of striped bass included in the tagging model by days at large in the Cape Fear River, 2012–2018.

Days at Large	n	Median	Mean	SD[Mean]	Minimum	Maximum
8 to 20	15	1	2.7	5	0	20
21 to 100	37	1	6.2	11.4	0	54
101 to 200	5	20	14.4	11.5	1	25
201 to 300	25	3	11.2	15	0	65
301 to 400	49	1	4.4	9.9	0	43
401 to 500	23	1	4.8	8.2	0	25
501 to 1,000	40	1	7.2	14.3	0	62
1,001 to 1,500	20	1	7	15.1	0	65
1,501 to 2,000	6	1	1.5	0.8	1	3
2,001 to 2,500+	1	56	56		56	56
All	221	1	6.5	12.3	0	65

Table 2.15. Mean, standard deviation (SD), minimum, and maximum number of days at large of striped bass recaptured by year, 2012–2018.

Year	n	Mean	SD[Mean]	Minimum	Maximum
2012	36	594.4	418.5	14	2,232
2013	54	559.8	485.3	12	1,870
2014	47	434.9	443.9	8	1,695
2015	29	412.6	348.7	21	1,371
2016	32	398.9	217.1	8	826
2017	18	231.6	189	12	467
2018	5	28.6	22.5	12	57
All	221	457.5	406.9	8	2,232

Table 2.16. Mean, standard deviation (SD), minimum, and maximum total length (TL) of striped bass recaptured by year in the Cape Fear River, 2012–2018.

Year	n	Mean TL (mm)	SE[Mean TL]	Minimum TL (mm)	Maximum TL (mm)
2012	36	611.6	94	456	845
2013	54	592.5	69.9	469	747
2014	47	600.2	89.1	380	814
2015	29	560.5	104.1	359	760
2016	32	570.7	83.5	382	766
2017	18	577.2	96.4	397	766
2018	5	481.2	51.3	402	534
All	221	586.7	89.1	359	845

Table 2.17. Mean, standard deviation (SD), minimum, and maximum growth (mm) of recaptured striped bass by days at large in the Cape Fear River, 2012–2018.

Days at Large	n	Mean (mm)	SD[Mean]	Minimum (mm)[6]	Maximum (mm)
8 to 20	11	2.7	2.8	0	9
21 to 100	29	11.8	13.6	0	69
101 to 200	4	29.5	24.4	3	62
201 to 300	22	64.5	45.8	4	192
301 to 400	49	67.6	45.3	7	255
401 to 500	21	80.5	43.10	19	154
501 to 1,000	41	126.9	63.5	15	221
1,001 to 1,500	21	133.3	73.4	29	306
1,501 to 2,000	6	242.8	55.9	181	332
2,001 to 2,500+	1	367.0		367	367

Table 2.18. Mean, standard deviation (SD), minimum, and maximum growth (mm) of striped bass recaptured by year in the Cape Fear River, 2012–2018.

Year	n	Mean (mm/day)	SD[Mean]	Minimum (mm/day)[6]	Maximum (mm/day)
2012	33	0.18	0.10	0.02	0.39
2013	52	0.16	0.14	0.01	0.78
2014	47	0.19	0.15	0.00	0.77
2015	24	0.20	0.12	0.04	0.57
2016	30	0.21	0.13	0.04	0.54
2017	16	0.24	0.18	0.08	0.75
2018	3	0.23	0.20	0.11	0.46
All	205	0.19	0.14	0.00	0.78

[6] Negative values were removed

Table 3.1. Summary of parameter values used to develop the demographic matrix model.

Parameter	Notation	Cape Fear	Neuse	Tar-Pamlico	Reference
Maximum age (yr)	T	7	11	11	Age-length data from three rivers 2004–2017
Asymtotic length (mm)	L_∞	759.7	874.4	838.7	Posterior median estimated using age-length data from three rivers 2004–2017
Growth coefficient (yr^{-1})	K	0.35	0.185	0.197	
Age at which fish has a length of zero (yr)	t_0	-0.003	-1.914	-1.696	
Maximum age for calculating M (yr)	t_{max}	7	11	11	Maximum age assumed for matrix model
Minimum age for calculating M (yr)	t_{min}		1		Minimum age assumed for matrix model
Mean constant natural mortality lower bound (yr^{-1})	m_1		0.6 for age 1-3; 0.1 for age 4+		Harris and Hightower 2017; Bradley et al. 2018
Mean constant natural mortality upper bound (yr^{-1})	m_2		1 for age 1-3; 0.5 for age 4+		
Coefficient of variation	CV		U(20%, 40%)		Jiao et al. 2009; Li and Jiao 2015
Fishery selectivity	g	0.014 for age 1; 0.13 for age 2; 0.6 for age 3; 0.94 for age 4; 0.99 for age 5; 1 for age > 5	0 for age < 3; 0.28 for age 3; 1 for age > 3	0 for age < 3; 0.12 for age 3; 1 for age > 3	Estimated from a catch-curve analysis using 2017 fishery-dependent data for Neuse and Tar-Pamlico Rivers, and 2017 fishery-independent data for Cape Fear River
Fishing mortality (yr^{-1})	F		0, 0.2, 0.4, 0.6, 0.8, 1		Hypothetical scenarios based on Rachels and Ricks 2015, Bradley et al. 2018
Sex ratio			1:1		
Proportion of viable eggs	x		0.64		Bradley et al. 2018b
Survival of offspring from birth to next census	S_0		0.000017		Estimated using Table 1 in Dahlberg 1979
Fecundity (number of eggs per mature female)	E	$\ln(E_t)$=12.484+ 0.205t	$\ln(E_t)$=12.52 +0.214t	$\ln(E_t)$ =12.429 +0.203t	Estimated using survey data from Neuse River and Tar-Pamlico River 2013–2014

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Table 3.1. **(*continued*)** Summary of parameter values used to develop the demographic matrix model.

Parameter	Notation	Cape Fear	Neuse	Tar-Pamlico	Reference
Maturity	w		0 for age ≤ 2, 1 for age ≥ 5		Survey data from Neuse River and Tar-Pamlico River 2013–2014; Olsen and Rulifson 1992; Boyd 2011
Maturity lower bound	w_1		0.29 for age 3, 0.94 for age 4		
Maturity upper bound	w_2		1 for ages 3 and 4		

Table 3.2. Initial year age structure for fishery management strategy evaluation.

Age	Proportion
1	0.35
2	0.16
3	0.12
4	0.1
5	0.08
6	0.08
7	0.06
8	0.05
9	0
10	0
11	0

Table 3.3. Population growth rate estimates from the matrix model. Pr is the probability of population growth rate greater than one.

	Cape Fear				Neuse				Tar-Pamlico			
F	**Median**	**Lower**	**Upper**	**Pr**	**Median**	**Lower**	**Upper**	**Pr**	**Median**	**Lower**	**Upper**	**Pr**
0	1.01	0.70	1.39	0.52	1.13	0.83	1.48	0.80	1.10	0.81	1.44	0.74
0.2	0.94	0.64	1.30	0.36	1.05	0.76	1.39	0.63	1.02	0.74	1.36	0.56
0.4	0.88	0.60	1.24	0.24	0.99	0.71	1.34	0.47	0.97	0.69	1.31	0.41
0.6	0.83	0.56	1.20	0.15	0.94	0.66	1.30	0.35	0.92	0.65	1.28	0.32
0.8	0.79	0.52	1.14	0.10	0.90	0.62	1.26	0.27	0.89	0.61	1.24	0.24
1	0.75	0.49	1.10	0.07	0.87	0.59	1.24	0.23	0.86	0.59	1.22	0.20

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Table 4.1. Cape Fear River tagging model parameters and priors. *U* denotes the uniform distribution.

Parameters	Values	Reference
Constant parameters		
Survival from tagging procedure	ϕ=1	
Immediate tag retention probability	ρ =1	
Tag reporting rate	λ =1	
Tag loss	Ω =0	
Priors		
Instantaneous total mortality (yr^{-1})	$\bar{Z}$ ~ U(0.1, 1.5)	Bradley et al. 2018; Harris and Hightower 2017
Instantaneous survey mortality ($month^{-1}$)	U ~ U(0, 0.1)	
Standard deviation of log-total mortality	σ_Z ~ U(0.001, 1)	

Table 4.2. Estimated instantaneous total mortality (Z, yr^{-1}) due to natural causes and fishing, estimated abundance (number) and estimated capture probability (α) from the tagging model in the Cape Fear River. Median—posterior median; Lower and Upper—lower and upper 95% credible intervals.

	Z (yr^{-1})			N (number)			α		
Year	**Median**	**Lower**	**Upper**	**Median**	**Lower**	**Upper**	**Median**	**Lower**	**Upper**
2012	0.96	0.53	1.43	10,983	5,418	23,479	0.036	0.017	0.073
2013	0.58	0.21	1.00	4,532	3,024	6,921	0.101	0.066	0.151
2014	1.13	0.71	1.47	7,372	4,623	11,708	0.080	0.051	0.128
2015	0.81	0.37	1.29	3,778	2,655	5,825	0.179	0.116	0.255
2016	0.63	0.24	1.09	3,335	2,191	5,573	0.176	0.105	0.268
2017	0.53	0.18	0.97	1,578	1,168	2,293	0.221	0.152	0.299
2018	0.73	0.21	1.41	1,914	1,415	2,765	0.205	0.142	0.277

Table 4.3. Estimated striped bass effort and catch in the Cape Fear River. (Source: Costal Angling Program (CAP) Central Southern Management Area (CSMA) recreational striped bass creel survey)

Year	Month	n Striped Bass Trips	n Striped Bass Hours	Harvest		Discard (numbers)				Total Catch (n fish)
				numbers	pounds	legal sized	over creel	undersized	slot	
2013	**Jan**									
	Feb									
	Mar									
	Apr	92	399					81		81
	May	165	470			263		11		274
	Total	257	870			263		92		355
	PSE	48.6	63.1			90.8		55.6		
2014	**Jan**									
	Feb									
	Mar	134	558							
	Apr	138	833			708		703		1,412
	May	161	748			122		17		139
	Total	433	2,140			830		721		1,551
	PSE	42.9	45.9			72.7		77.5		
2015	**Jan**									
	Feb									
	Mar	110	422			22				
	Apr	19	181					162		162
	May	79	100					15		15
	Total	209	702			22		176		199
	PSE	50.1	53			100		57.4		
2016	**Jan**									
	Feb									
	Mar	179	750			10		12		22
	Apr	87	315			17				17
	May	126	399			588				588
	Total	391	1,464			616		12		628
	PSE	46.4	44.4			95.8		100		

Table 4.3. (***continued***) Estimated striped bass effort and catch in the Cape Fear River. (Source: Costal Angling Program (CAP) Central Southern Management Area (CSMA) recreational striped bass creel survey)

Year	Month	n Striped Bass Trips	n Striped Bass Hours	Harvest		Discard (numbers)				Total Catch (n fish)
				numbers	pounds	legal sized	over creel	undersized	slot	
2017	**Jan**									
	Feb	26	159			14				14
	Mar									
	Apr									
	May									
	Total	26	159			14				14
	PSE	100..0	100			100				
2018	**Jan**									
	Feb									
	Mar	18	35							
	Apr									
	May	7	26			140				140
	Total	24	61			140				140
	PSE	77.1	71.5			70.8				

Table 5.1. Fit of the candidate models. Com = commercial; Rec = recreational; DO = dissolved oxygen (mg/L); K = the number of parameters; AIC_c = Akaike's information criterion corrected for small sample size; Δ_i = Akaike difference; w_i = Akaike weight. The candidate models from Rachels and Ricks (2018) are formatted in **bold**.

Model	*K*	AIC_c	Δ_i	w_i	R^2
Com effort	**2**	**-20.41**	**0**	**0.152**	**0.21**
Com effort, Com harvest	**3**	**-19.27**	**1.14**	**0.086**	**0.43**
Rec effort	2	-19.15	1.26	0.081	0.11
Rec discard	2	-18.89	1.52	0.071	0.09
Com harvest	**2**	**-18.88**	**1.53**	**0.071**	**0.08**
Rec total catch	2	-18.77	1.64	0.067	0.075
Rec effort, Com effort	3	-18.68	1.73	0.064	0.39
Rec harvest, Rec effort	3	-18.5	1.91	0.058	0.38
DO	**2**	**-18**	**2.41**	**0.045**	**0.001**
Rec harvest	2	-17.99	2.42	0.045	0
Rec total removal	2	-17.99	2.42	0.045	0
Com effort, Temperature	**3**	**-17.61**	**2.8**	**0.037**	**0.32**
Com effort, DO	**3**	**-16.62**	**3.79**	**0.023**	**0.25**
Rec harvest, Com effort	3	-16.57	3.84	0.022	0.25
Rec effort, Temperature	3	-16.1	4.31	0.018	0.21
Rec effort, DO	3	-15.69	4.72	0.014	0.18
Rec discard, Rec effort	3	-15.36	5.05	0.012	0.15
Rec effort, Com harvest	3	-15.26	5.15	0.012	0.14
Com harvest, Temperature	**3**	**-14.94**	**5.47**	**0.010**	**0.12**
Rec harvest, Com harvest	3	-14.86	5.55	0.009	0.11
Rec discard, Temperature	3	-14.76	5.65	0.009	0.1
Rec discard, DO	3	-14.65	5.76	0.009	0.09
Rec discard, Rec harvest	3	-14.61	5.8	0.008	0.09
Com harvest, DO	**3**	**-14.59**	**5.82**	**0.008**	**0.08**
DO, Temperature	**3**	**-13.86**	**6.55**	**0.006**	**0.015**
Rec harvest, Temperature	3	-13.82	6.59	0.006	0.01
Rec harvest, DO	3	-13.72	6.69	0.005	0.002
Rec discard, Rec effort, Rec harvest	4	-12.82	7.59	0.003	0.4
Com effort, DO, Temperature	**4**	**-11.88**	**8.53**	**0.002**	**0.34**
Com harvest, DO, Temperature	**4**	**-10.51**	**9.9**	**0.001**	**0.24**
Rec discard, Rec harvest, Com harvest	4	-10.37	10.04	0.001	0.23
Com effort, Com harvest, DO, Temperature	**5**	**-6.55**	**13.86**	**0.000**	**0.54**

Table 6.1. Estimated parameter values of the von Bertalanffy age-length relationship and their associated standard errors (SE) where total length was measured in millimeters (n=166).

Parameter	Value	SE
L_∞	787	65
K	0.26	0.084
t_0	-0.94	0.72

Table 6.2. Estimated parameter values of the length-weight relationship and their associated standard errors (SE) where total length was measured in millimeters and weight was measured in grams (n=198).

Parameter	Value	SE
a	2.4E-06	9.5E-07
b	3.2	6.2E-02

Table 6.3. Estimated natural mortality (*M*) at age based on Lorenzen's (1996) approach. The values given represent instantaneous rates.

Age	*M*
1	0.60
2	0.45
3	0.38
4	0.34
5	0.31
6	0.30
7	0.29

Table 6.4. Estimated parameter values of the logistic length-maturity relationship and their associated standard errors (SE) where total length was measured in millimeters (n=170).

Parameter	Value	SE
a	-49	18
b	0.10	0.037

Table 6.5. Definitions of symbols used in the per-recruit equations.

Symbol	Definition	Units
t	age	years
F_t	fishing mortality at age t	year^{-1}
F_{full}	fully-recruited fishing mortality	year^{-1}
S_t	selectivity at age t	proportion
Z_t	total mortality at age t	year^{-1}
M_t	natural mortality at age t	year^{-1}
N_1	number of fish at age 1	numbers of fish
N_t	number of fish at age t	numbers of fish
B_t	population biomass at age t	kilograms
w_t	individual weight at age t	grams
U_t	population size at age t for non-hatchery origin fish	numbers of fish
h	assumed proportion of hatchery fish in the population	proportion
H_t	population size at age t for hatchery-origin fish	numbers of fish
C_t	catch at age t	numbers of fish
YPR	yield per recruit	numbers of fish
W_t	weight of catch at age t	kilograms
WPR	weight per recruit	kilograms
SSB	spawning stock biomass	kilograms
SSU_t	SSB at age t for non-hatchery female fish	kilograms
p	proportion of individuals in the population that are female	proportion
mat_t	maturity at age t	proportion
f	proportion of fishing mortality that occurs before spawning	proportion
m	proportion of natural mortality that occurs before spawning	proportion
SSU/R	SSB per recruit for the non-hatchery female fish	kilograms
SSH_t	SSB at age t for hatchery-origin female fish	kilograms
SSH/R	SSB per recruit for hatchery-origin female fish	kilograms
SSB/R	SSB per recruit for the entire population	kilograms
EU_t	total number of eggs at age t for the non-hatchery female fish	numbers of eggs
EU/R	eggs per recruit for the non-hatchery female fish	numbers of eggs
EH_t	total number of eggs at age t for hatchery-origin female fish	numbers of eggs
EH/R	eggs per recruit for hatchery-origin female fish	numbers of eggs
E/R	eggs per recruit for the entire population	numbers of eggs
%SPR	spawning potential ratio	percentage

Table 6.6. Sample frequency at (genetic) age of striped bass collected in the Neuse River by the NCWRC's Spawning Stock Survey in 2017. Catches have been standardized to a collection time of 19 minutes.

Age	Frequency
1	0
2	8
3	123
4	88
5	37
6	36
7	7

Table 6.7. Estimates of fishing mortality (F) at age derived from the catch curve analysis.

Age	F
1	0
2	0.0092
3	0.25
4	0.33
5	0.33
6	0.33
7+	0.33

Table 7.1. Number of scales, otoliths, and genetic (PBT) structures collected by NCDMF available for CSMA striped bass age determination, 1975–2018. Genetic (PBT) structures are only available from 2016–2018.

Year	Scale	Otolith	PBT		Year	Scale	Otolith	PBT
1975	77	0			**1997**	0	0	
1976	4	0			**1998**	1	8	
1977	2	0			**1999**	18	0	
1978	32	0			**2000**	57	0	
1979	29	0			**2001**	50	0	
1980	105	0			**2002**	204	0	
1981	0	0			**2003**	334	64	
1982	0	0			**2004**	254	66	
1983	16	0			**2005**	532	86	
1984	18	0			**2006**	484	115	
1985	9	0			**2007**	335	87	
1986	0	0			**2008**	242	114	
1987	2	0			**2009**	316	39	
1988	4	0			**2010**	671	156	
1989	7	0			**2011**	688	196	
1990	0	0			**2012**	766	248	
1991	0	0			**2013**	993	189	
1992	0	0			**2014**	376	181	
1993	0	0			**2015**	413	107	
1994	0	0			**2016**	592	123	322
1995	0	0			**2017**	599	132	261
1996	0	0			**2018**	719	219	201
					Total	8,949	2,130	784

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Table 7.2. Mean percentage age bias (bias compared to genetic age) for each reader for overall age bias and age bias by method type (standard deviation in parentheses). Cells with no values indicate the reader performed no readings for that method type.

Reader ID	Overall % Age Bias	Otolith % Age Bias	Scale % Age Bias
1	-0.274 (14.0)	-0.899 (8.5)	-0.0935 (15.2)
2	15.3 (22.2)	-1.81 (7.3)	23.1 (22.3)
3	-0.603 (13.3)		-0.603 (13.3)
4	-1.12 (12.4)		-1.12 (12.4)
5	7.81 (17.3)		7.81 (17.3)

Table 7.3. Parameter estimates from Bayesian generalized linear mixed effects model for scale ages and otolith ages compared to genetic ages. Estimates are median of posterior distributions with confidence interval in parentheses.

Parameter		Estimates
Reader ID random effects		
	α_1	-0.858 (-1.31, -0.304)
	α_2	2.47 (0.373, 8.96)
	α_3	-0.931 (-1.47, -0.399)
	α_4	-1.01 (-1.61, -0.505)
	α_5	0.280 (-0.527, 2.63)
	p_r	1.70 (0.1, 10.7)
	σ_r	1.67 (0.589, 5.34)
Ageing method fixed effects		
Otolith:	γ_1	-1.19 (-2.88, 0.507)
Scale:	γ_2	7.90 (1.37, 16.6)
Random error		
	p_e	98.3 (89.3, 99.9)
	σ_e	15.5 (15.0, 16.0)

Table 7.4. Coefficient of variation (%) analyses results for between readers for scale ages. Values in parentheses are percent agreement. Values in **bold** are significant ($P < 0.01$). Between reader coefficients of variation differ depending on which reader is the reference reader.

		Reader						
		1	2	3	4	5	6	7
	1		**6.1 (31)**	**4.7 (65)**	**3.2 (59)**	3.8 (72)	**5.4 (24)**	**4.4 (19)**
	2	**5.2 (31)**		**4.3 (38)**	**3.8 (46)**	**5.5 (30)**		
	3	**5.1 (65)**	**6.3 (38)**		**3.2 (67)**	2.5 (88)		
Reader	4	**5.8 (59)**	**5.4 (46)**	**4.9 (67)**		**6.0 (66)**		
	5	3.6 (72)	**7.0 (30)**	2.8 (88)	**3.1 (66)**			**4.3 (22)**
	6	**5.2 (24)**						
	7	**4.0 (19)**				**3.6 (22)**		

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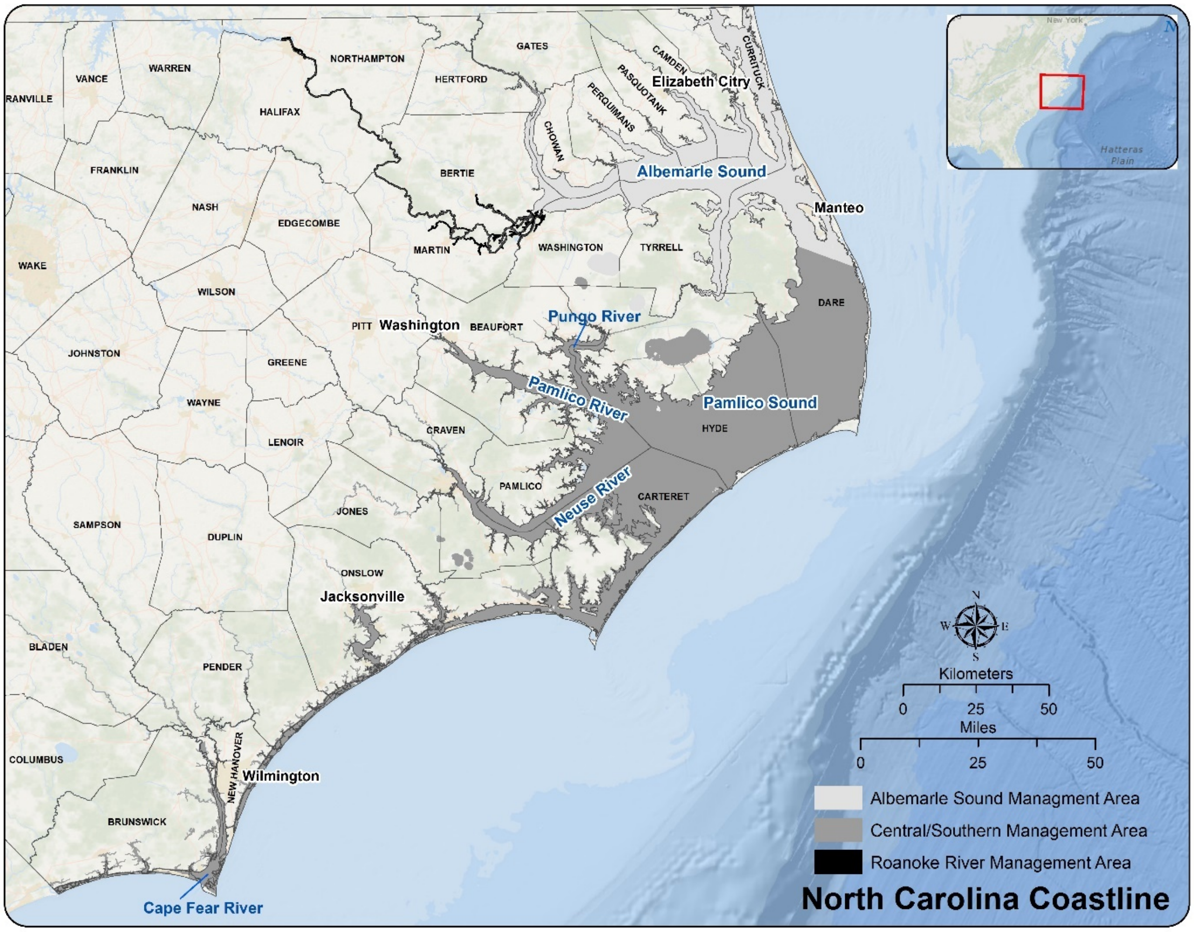

Figure 1.1. Boundary lines between the Albemarle Sound Management Area, Central Southern Management Area, and the Roanoke River Management Area.

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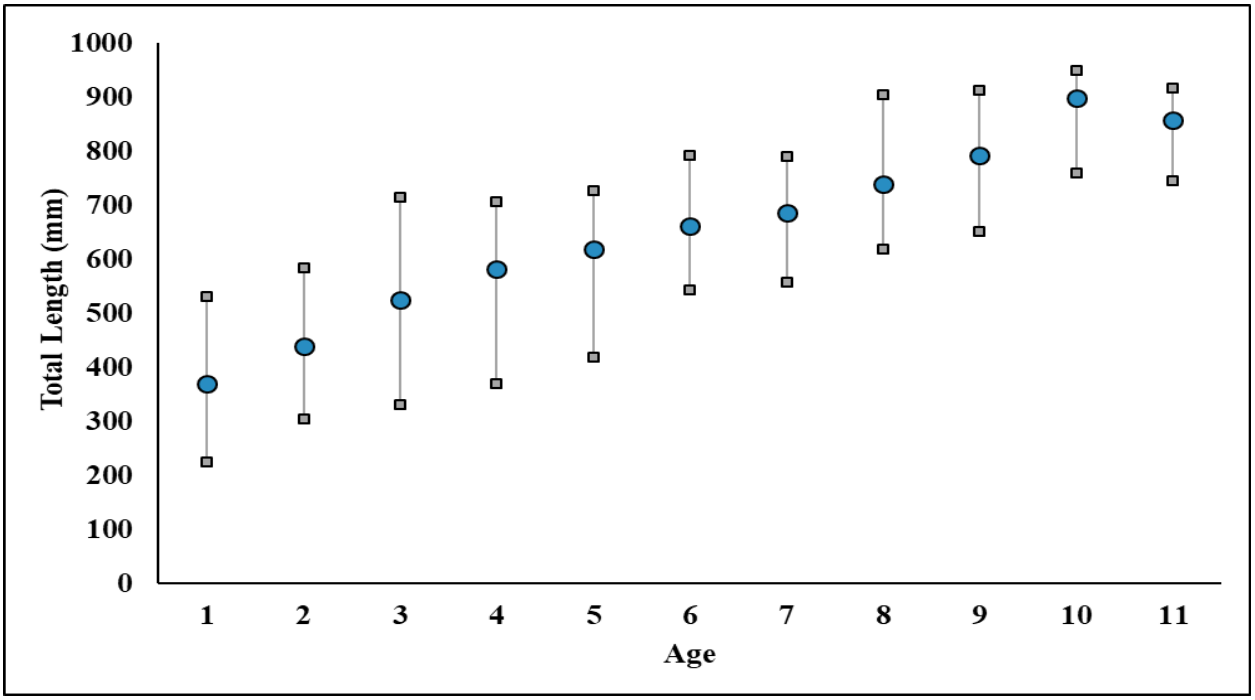

Figure 1.2. CSMA striped bass length at age based on otolith and genetic age samples collected by NCDMF, 2004–2018. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age.

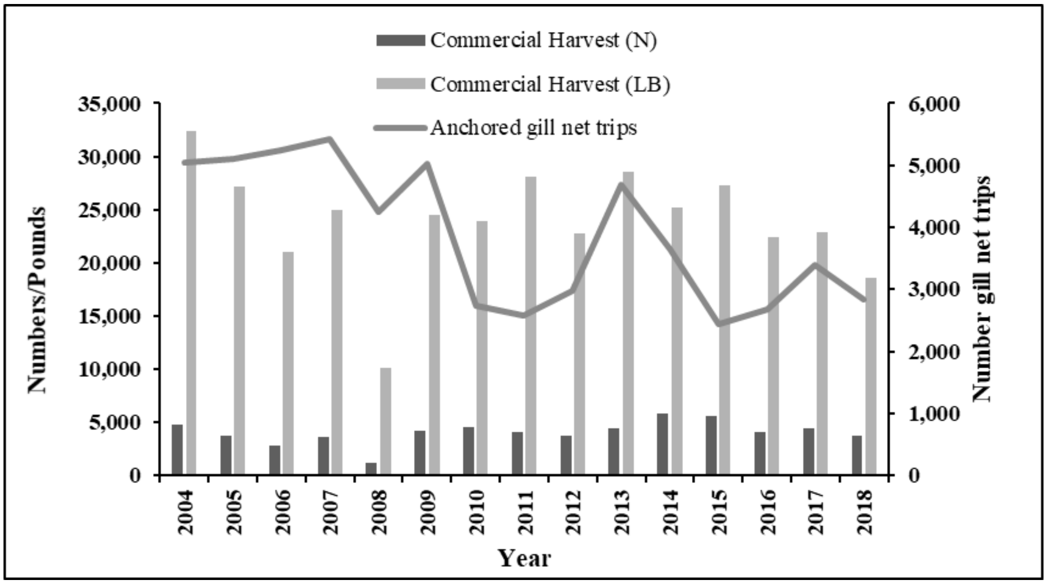

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Figure 2.1. Commercial striped bass harvest in numbers and pounds and anchored gill-net trips in the Tar-Pamlico, Pungo, Neuse, and Bay rivers, 2004–2018.

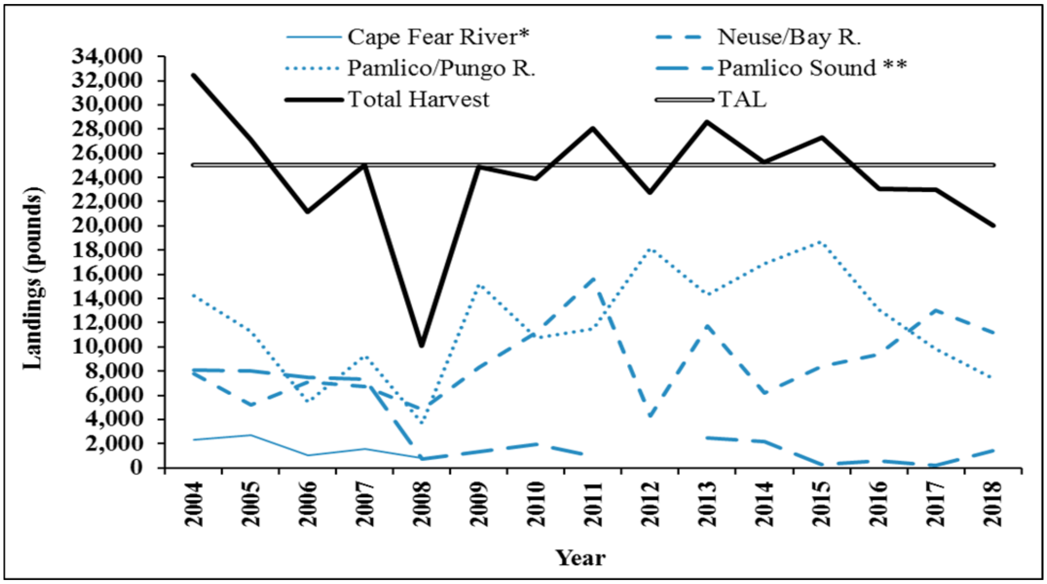

Figure 2.2. Commercial striped bass harvest by system, and the TAL in the CSMA, 2004–2018. *There has been a harvest moratorium in the Cape Fear River since 2008. **Landings data for the Pamlico Sound in 2012 are confidential.

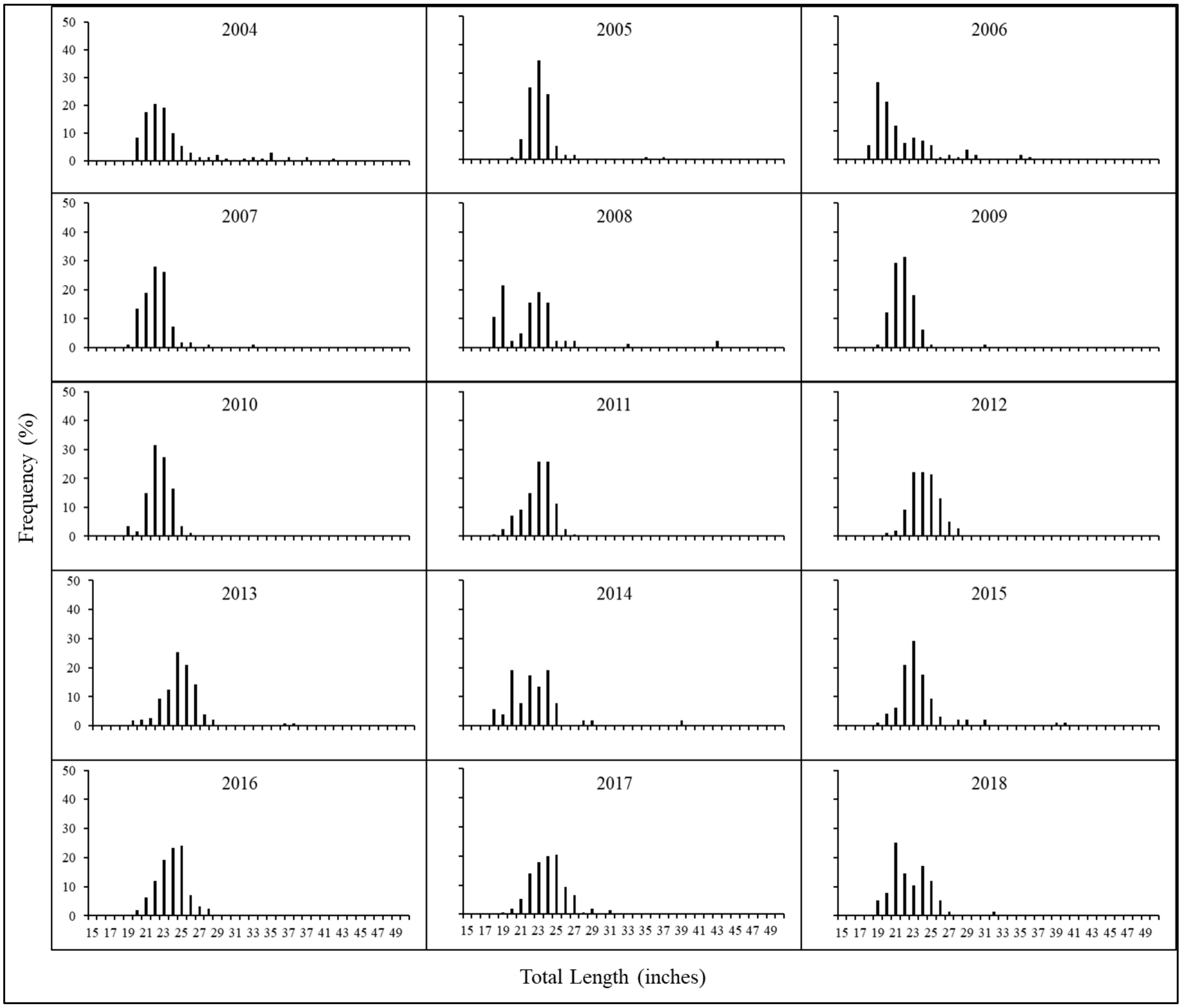

Figure 2.3. Length frequency of CSMA striped bass landed commercially in the Tar-Pamlico and Pungo rivers, 2004–2018.

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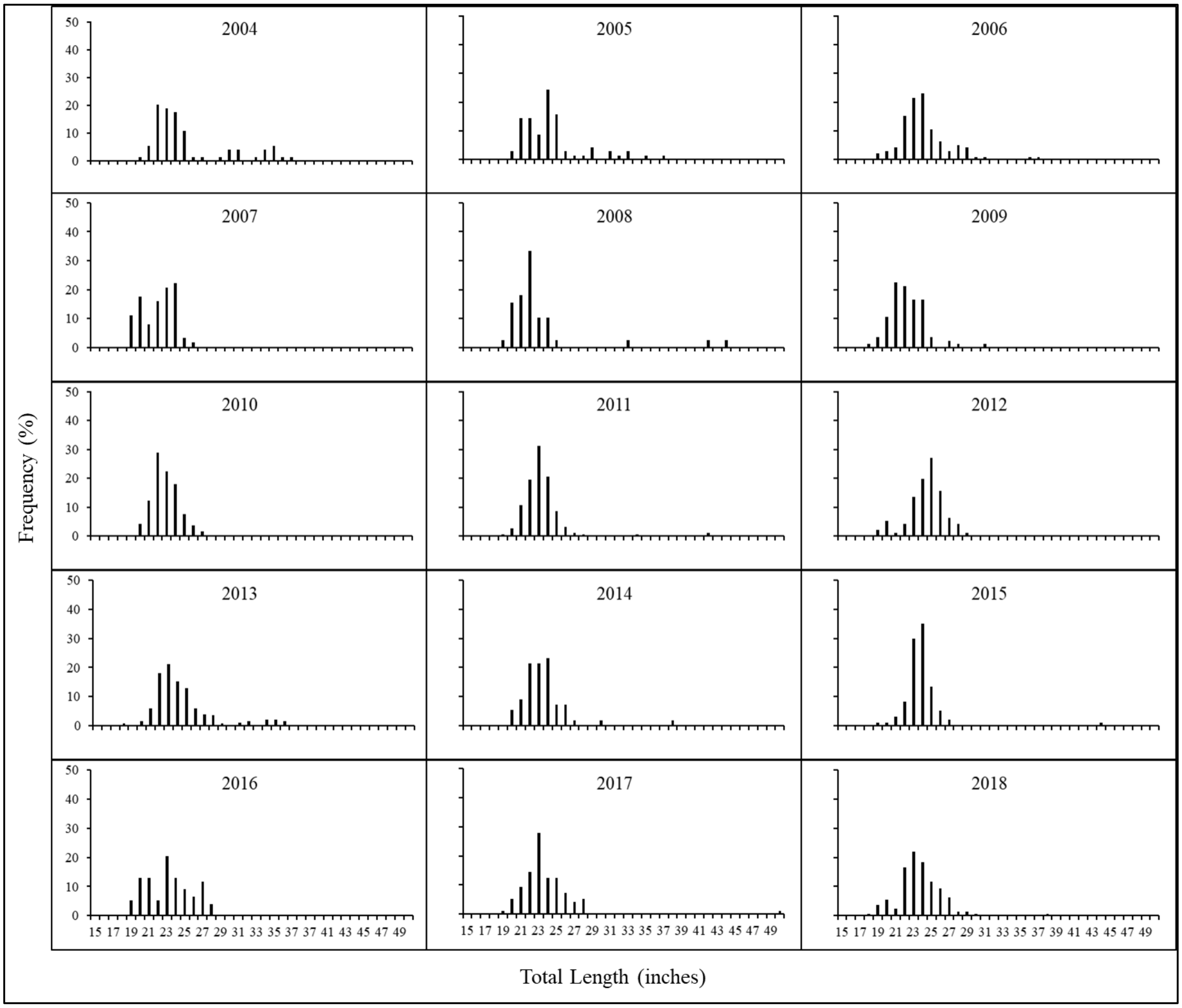

Figure 2.4. Length frequency of CSMA striped bass landed commercially in the Neuse and Bay rivers, 2004–2018.

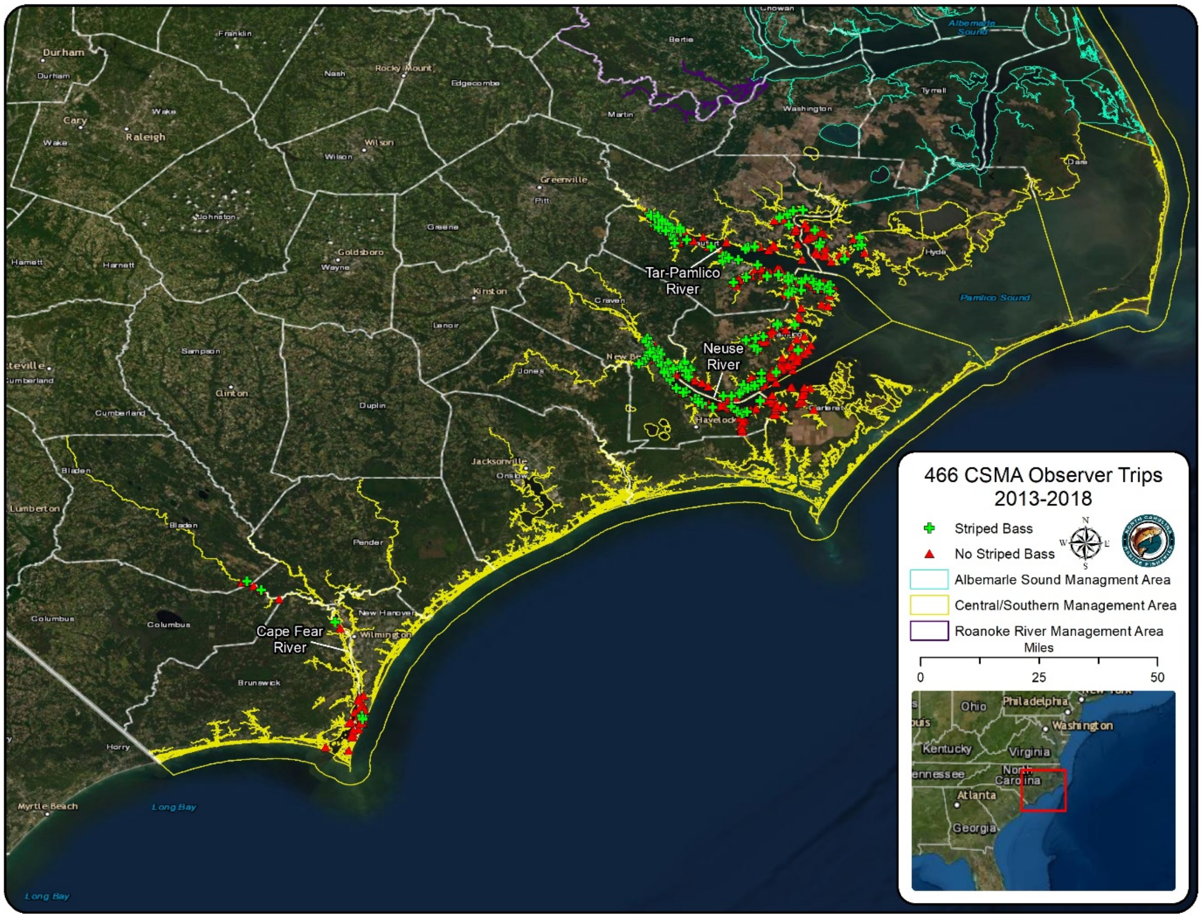

Figure 2.5. Program 466 CSMA observer trips by the presence or absence of striped bass, 2013–2018. The cross sign is an observer trip that encountered a striped bass (n=284), and the triangle is an observer trip that did not encounter striped bass (n=789).

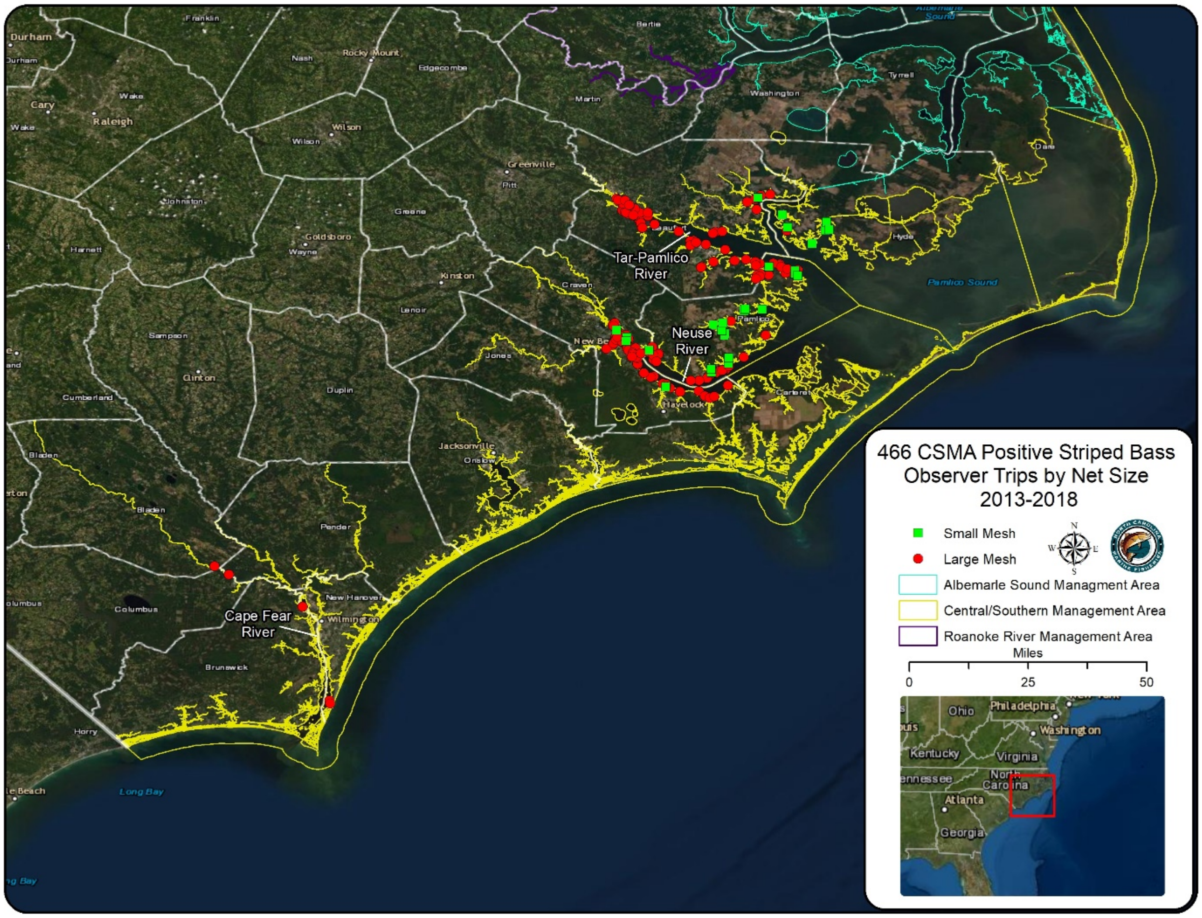

Figure 2.6. Program 466 CSMA observer trips by mesh size, 2013–2018. The square is a small mesh observer trip that encountered striped bass (n=38), and the circle is a large mesh observer trip that encountered striped bass (n=246). Eight large mesh observer trips accounted for 37 striped bass that are not presented on the map due the absence of coordinates.

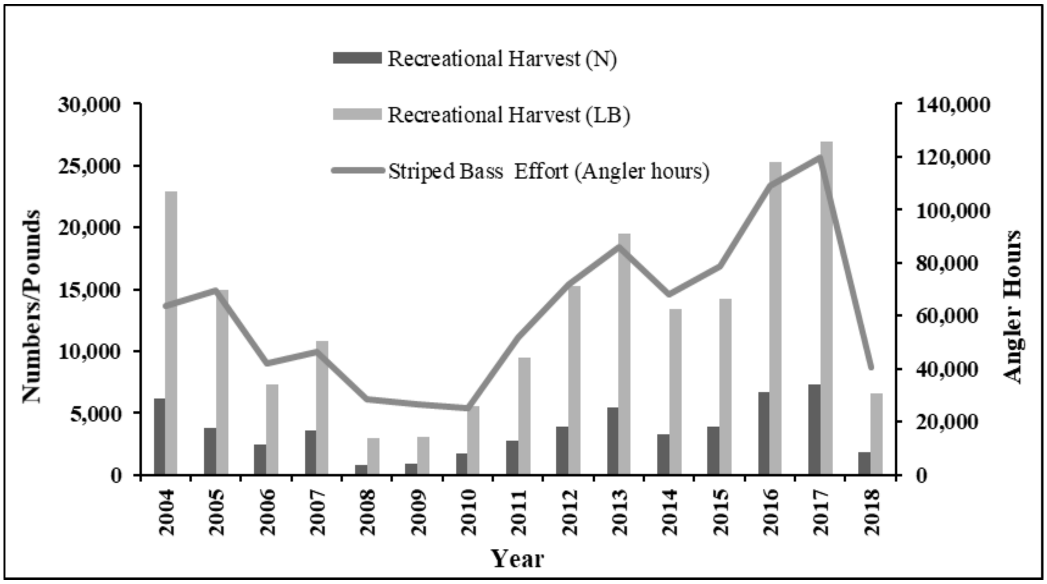

Figure 2.7. Recreational striped bass harvest in numbers and pounds and effort in angler hours for the Tar-Pamlico and Neuse rivers and tributaries, 2004–2018.

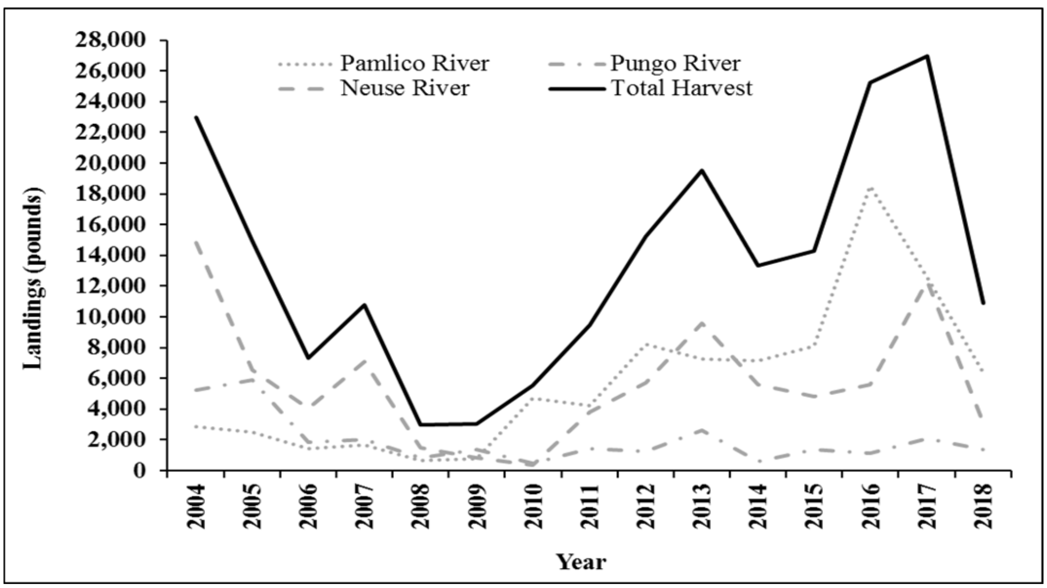

Figure 2.8. Recreational striped bass harvest in the Tar-Pamlico, Pungo, and Neuse rivers, 2004–2018.

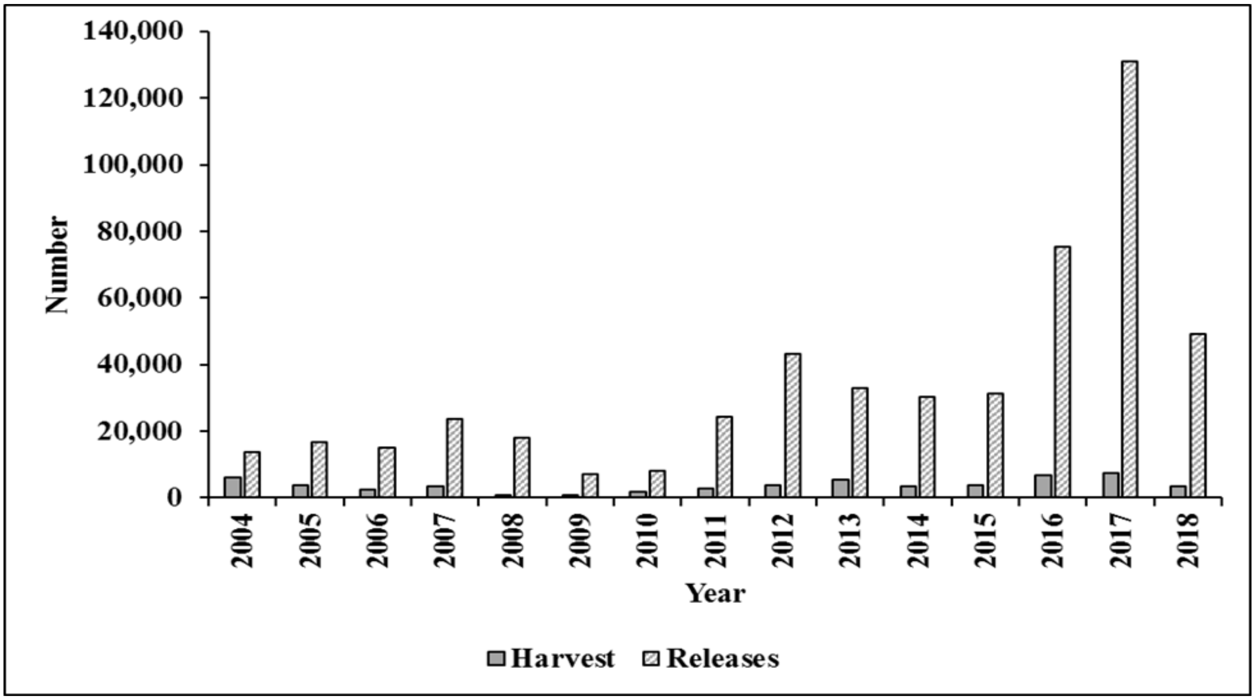

Figure 2.9. Annual recreational catch (released and/or harvested) of striped bass in the CSMA, 2004–2018.

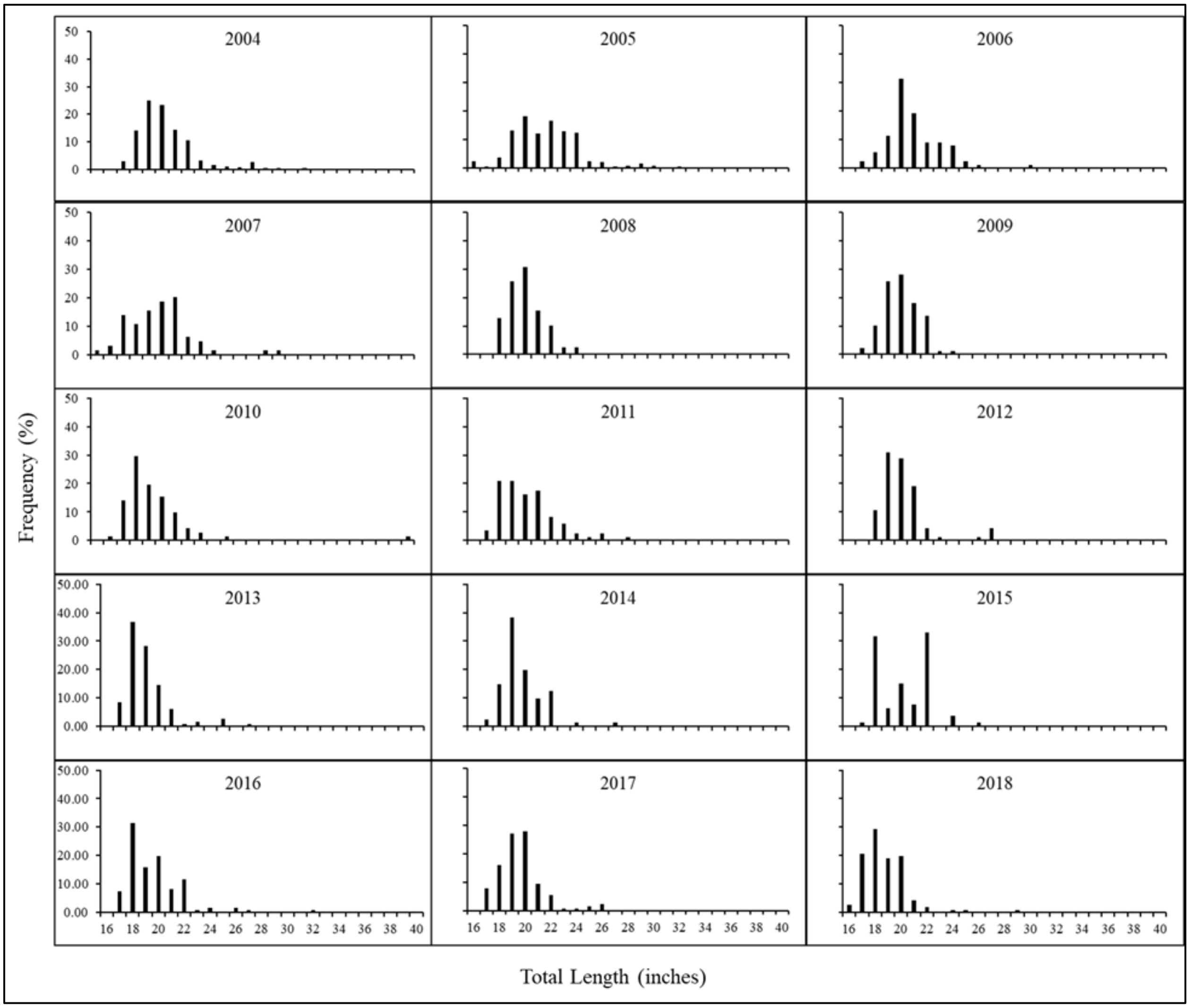

Figure 2.10. Length frequency of CSMA striped bass recreationally harvested in the Tar-Pamlico and Pungo rivers, 2004–2018.

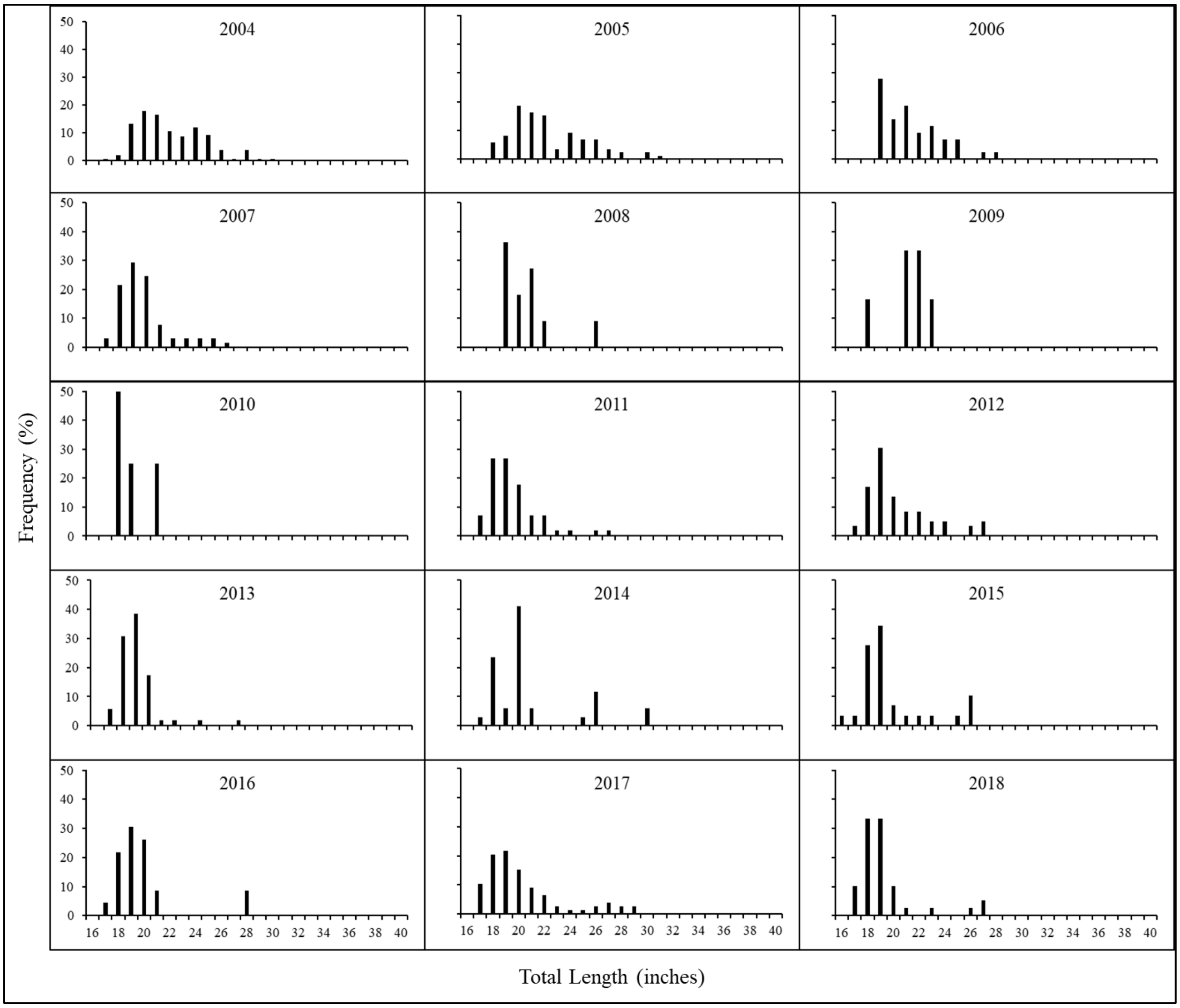

Figure 2.11. Length frequency of CSMA striped bass recreationally harvested in the Neuse River, 2004–2018.

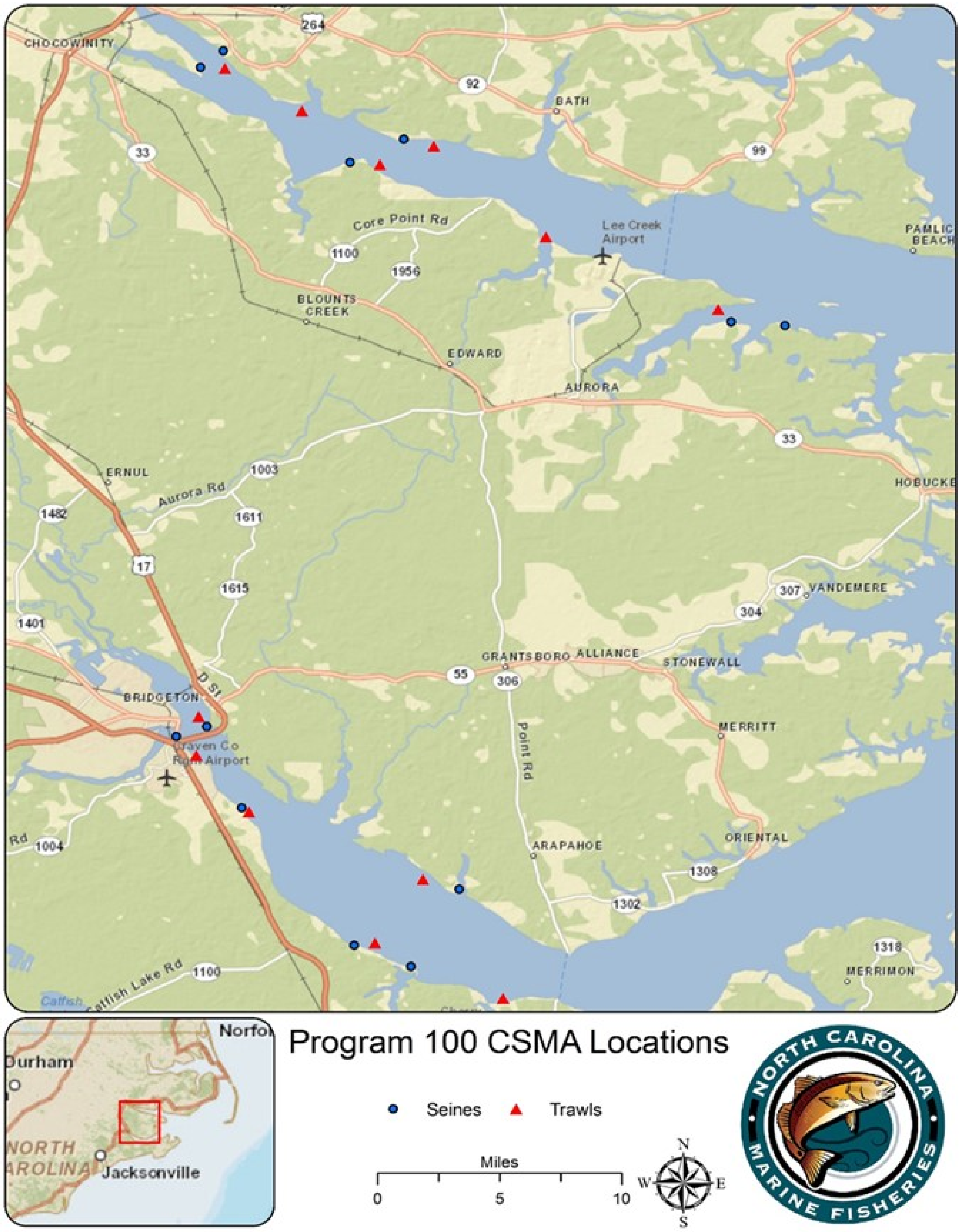

Figure 2.12. Location of Central Southern Management Area (CSMA) juvenile striped bass beach seine and trawl sites, Tar-Pamlico and Neuse rivers, NC.

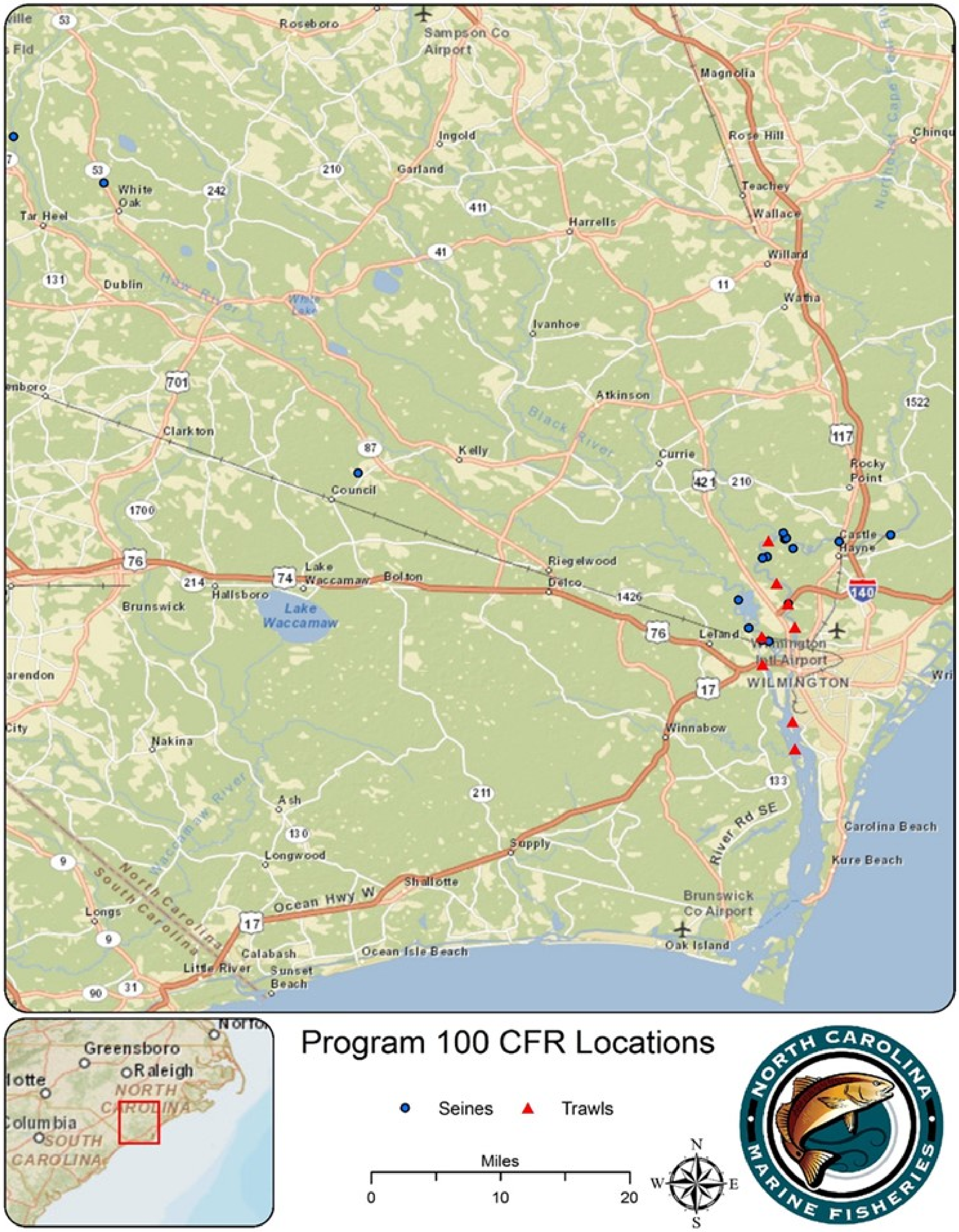
Program 100 CFR Locations
Seines
Trawls
Miles
0
10
20
N
S
W
E
NORTH CAROLINA MARINE FISHERIES
Greensboro
Raleigh
NORTH CAROLINA
SOUTH CAROLINA
Columbia
Roseboro
Sampson Co Airport
Magnolia
Rose Hill
Teachey
Wallace
Willard
Watha
Harrells
Ingold
Garland
White Oak
Tar Heel
Dublin
Ivanhoe
Atkinson
Black River
Clarkton
Kelly
Council
Currie
Rocky Point
Castle Hayne
Riegelwood
Delco
Leland
Wilmington Intl Airport
WILMINGTON
Lake Waccamaw
Bolton
Hallsboro
Brunswick
Nakina
Winnabow
Ash
Longwood
Supply
Shallotte
Ocean Hwy W
Longs
Little River
Calabash
Sunset Beach
Ocean Isle Beach
Brunswick Co Airport
Oak Island
Carolina Beach
Kure Beach
River Rd SE
Waccamaw River
North Carolina
South Carolina

Figure 2.13. Location of Cape Fear River juvenile striped bass beach seine and trawl sites, CapeFear River, NC.

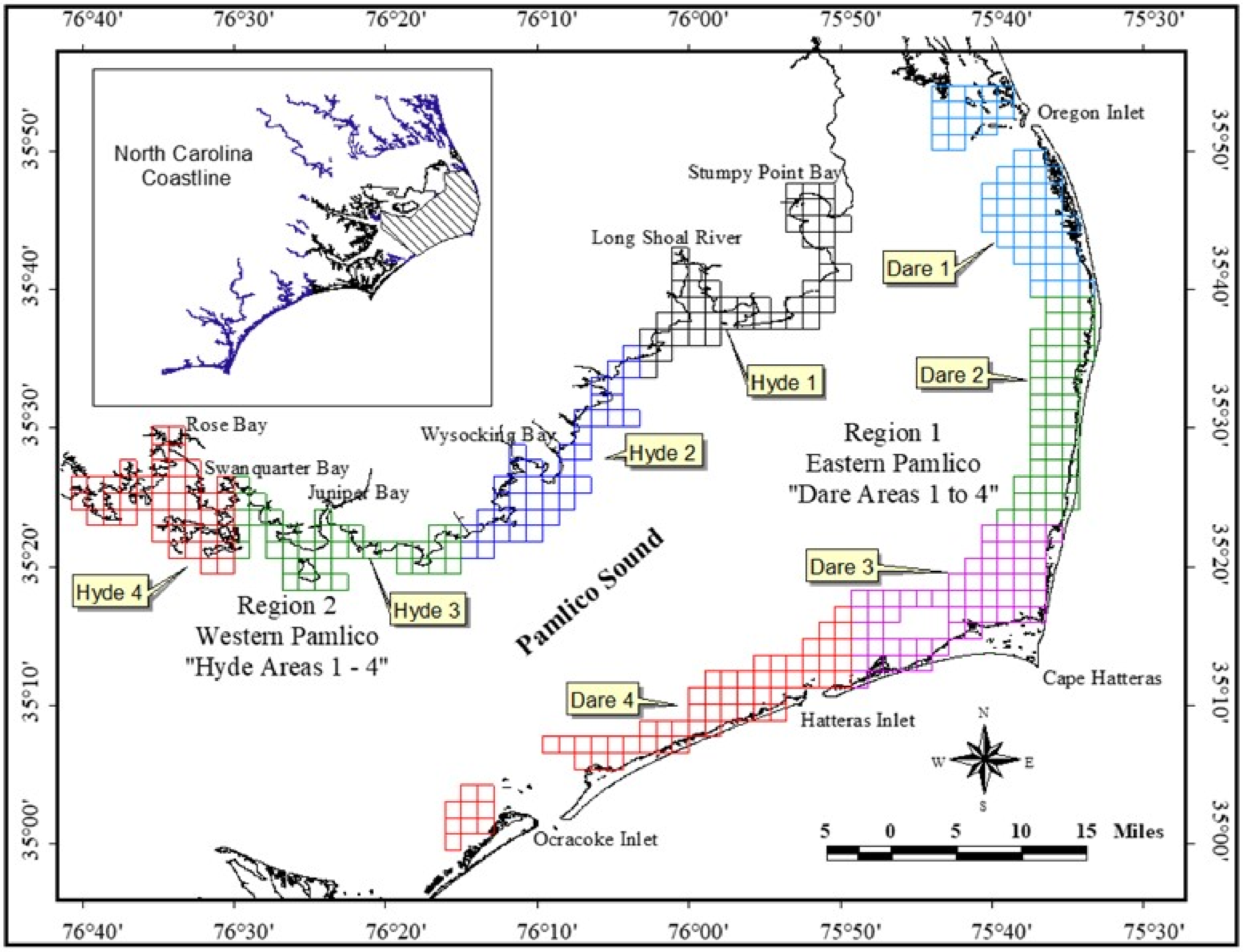

Figure 2.14. The sample regions and grid system for P915 in Dare (Region 1) and Hyde (Region 2) counties.

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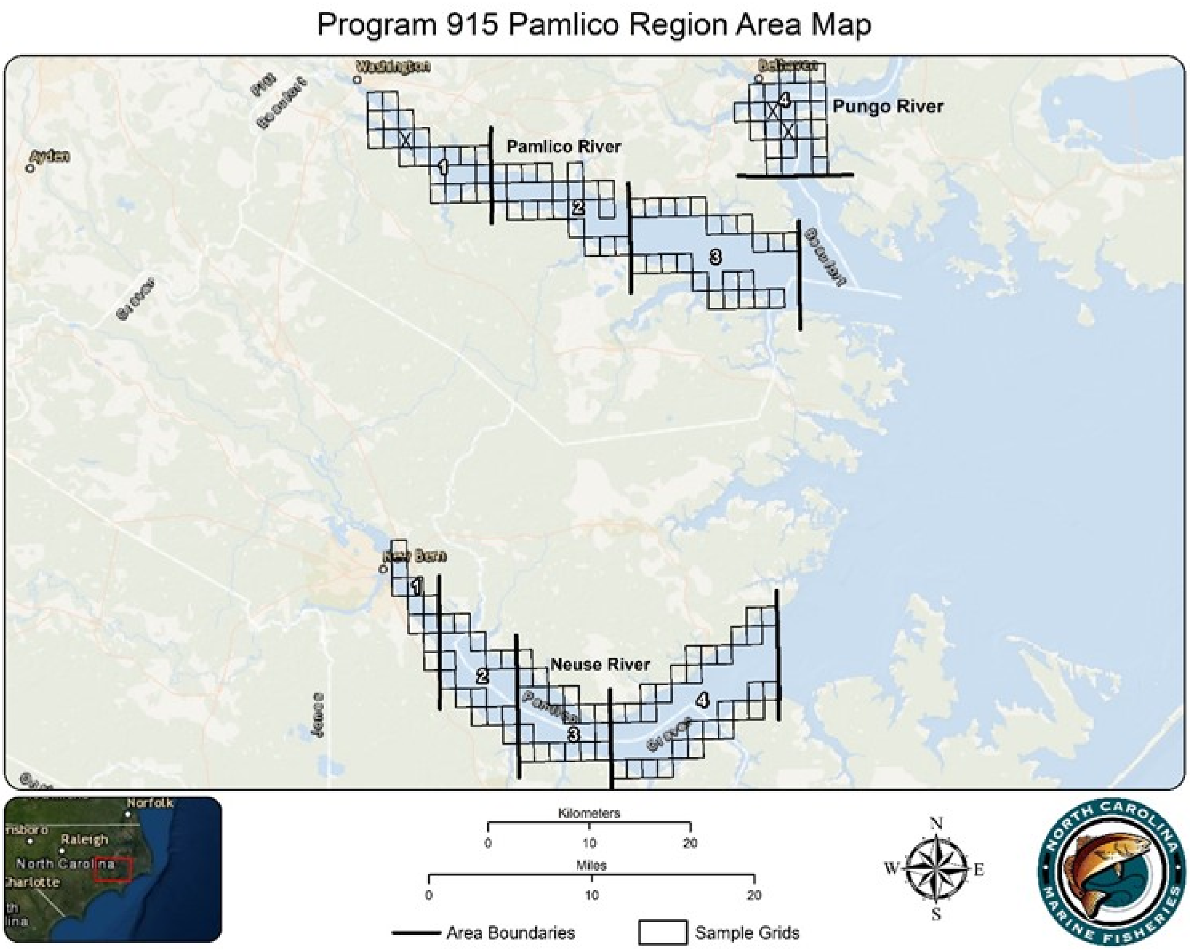

Figure 2.15. The sample areas and grid system for P915 in the Pamlico Region (Pamlico, Pungo and Neuse rivers) with areas numbered Pamlico/Pungo: 1—Upper, 2—Middle, 3—Lower, 4—Pungo; Neuse: 1—Upper, 2—Upper-middle, 3—Lower-middle, and 4—Lower).

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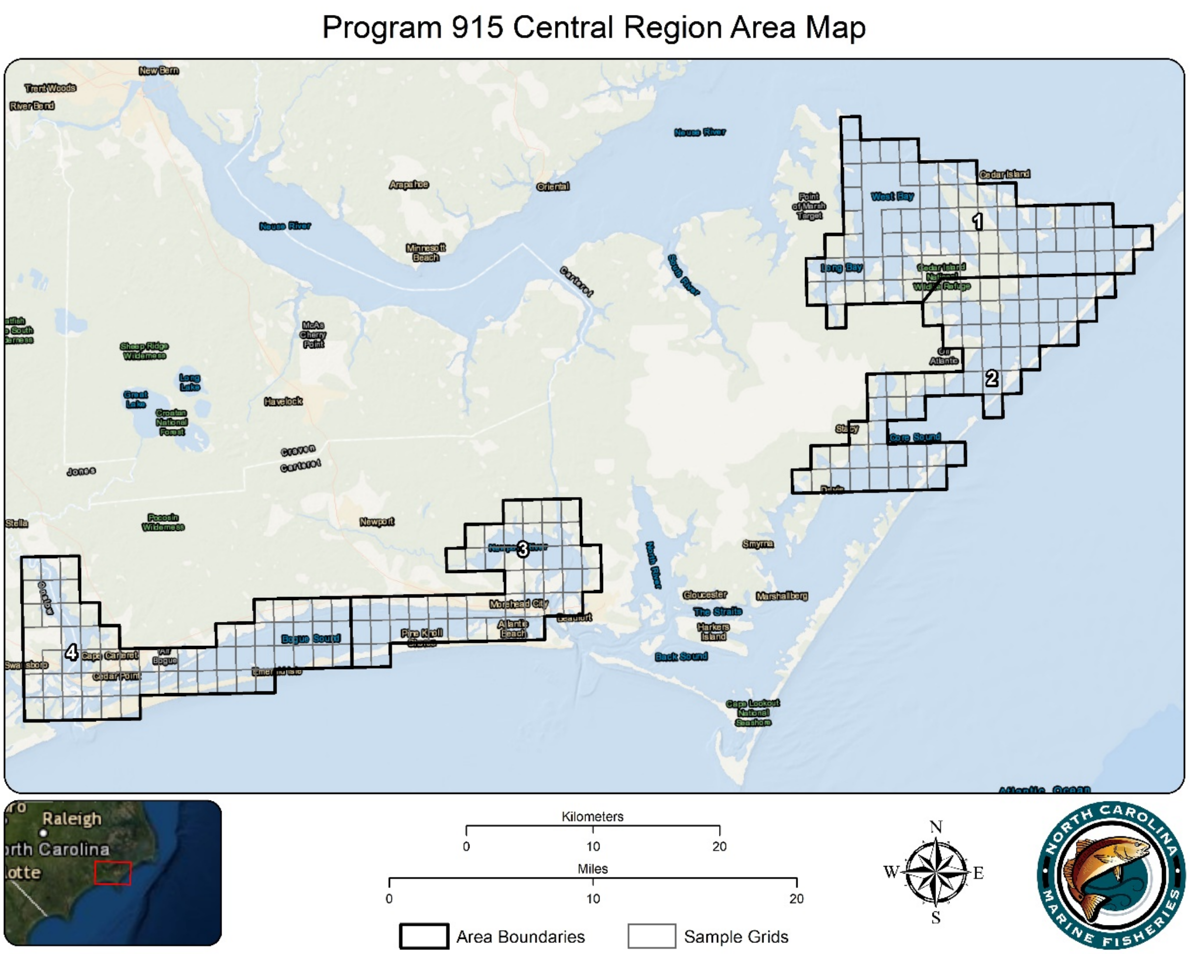

Figure 2.16. The sample areas and grid system for P915 in the Central Region with areas numbered (1—West Bay/Upper Core Sound, 2—Lower Core Sound, 3—Newport River/Bogue Sound, and 4—Bogue Sound/White Oak River). Sampling began May 2018.

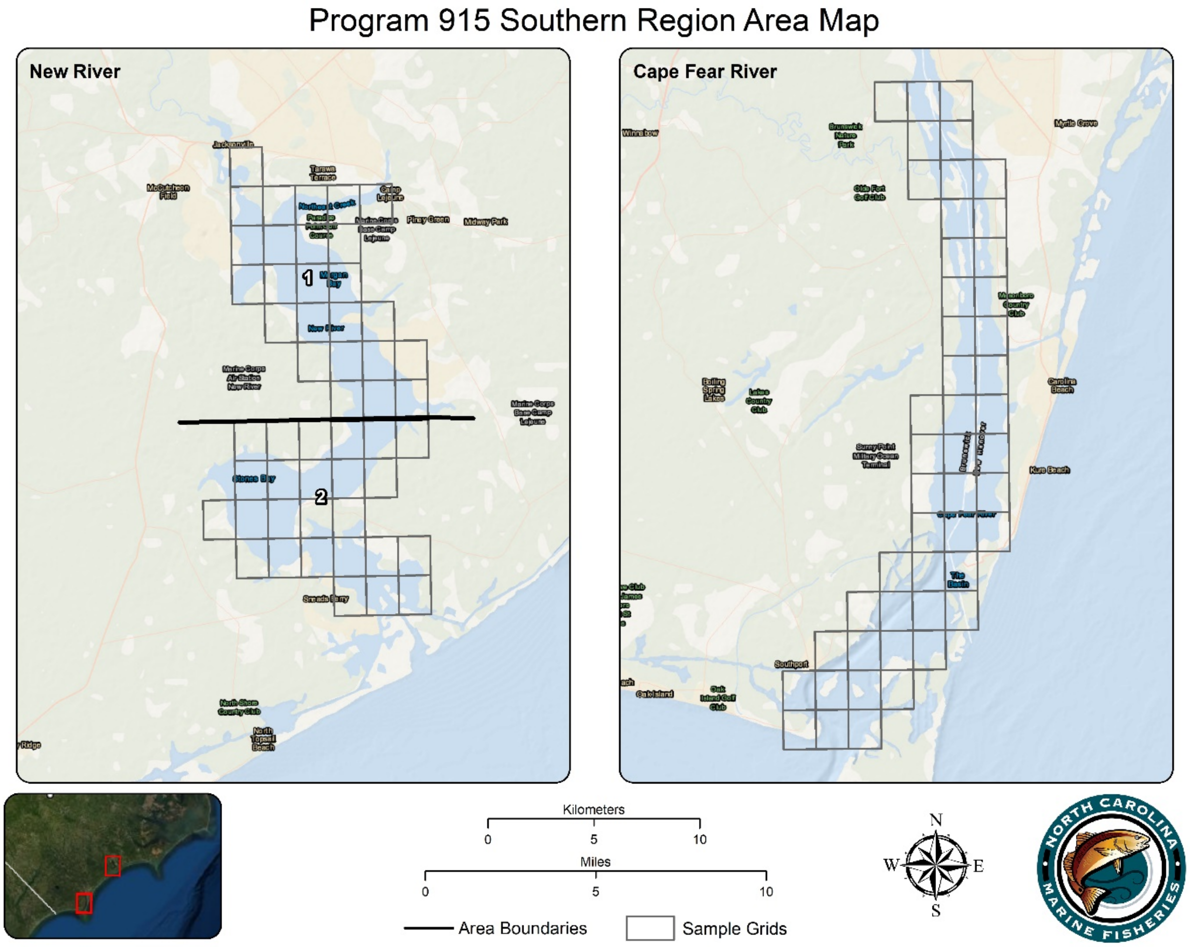

Figure 2.17. The sample areas and grid system for P915 in the Southern Region (New and Cape Fear rivers) with areas numbered (New: 1—Upper, 2—Lower, Cape Fear).

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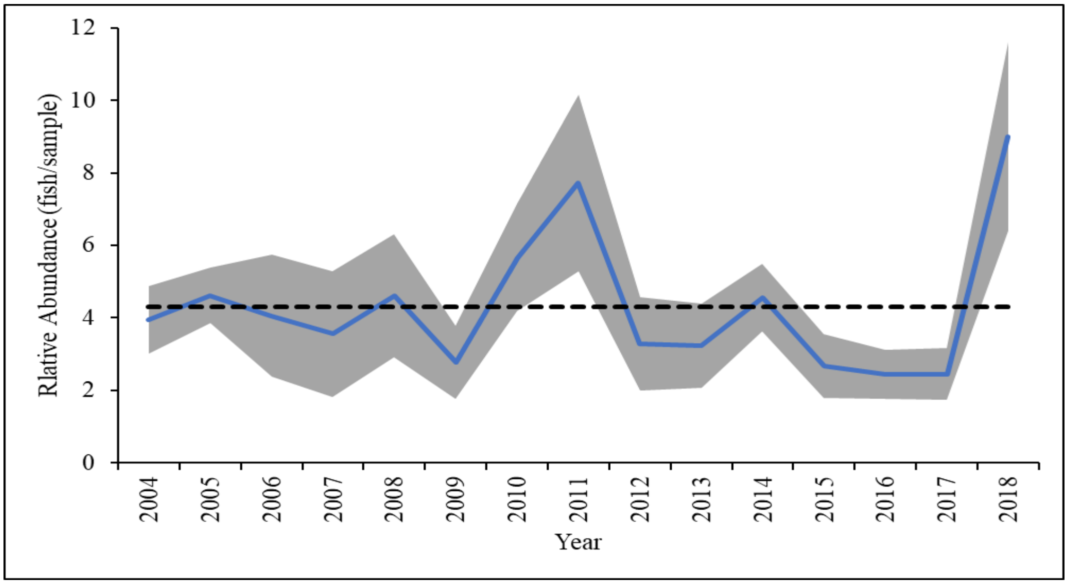

Figure 2.18. Striped bass annual weighted relative abundance index (# fish per sample; sample=240 yards of gill net) in P915, 2004–2018 (Tar-Pamlico River, shallow sets, April and October–November). Dashed black line represents time-series average. Shaded area represents standard error. Soak times were not used in calculating the index.

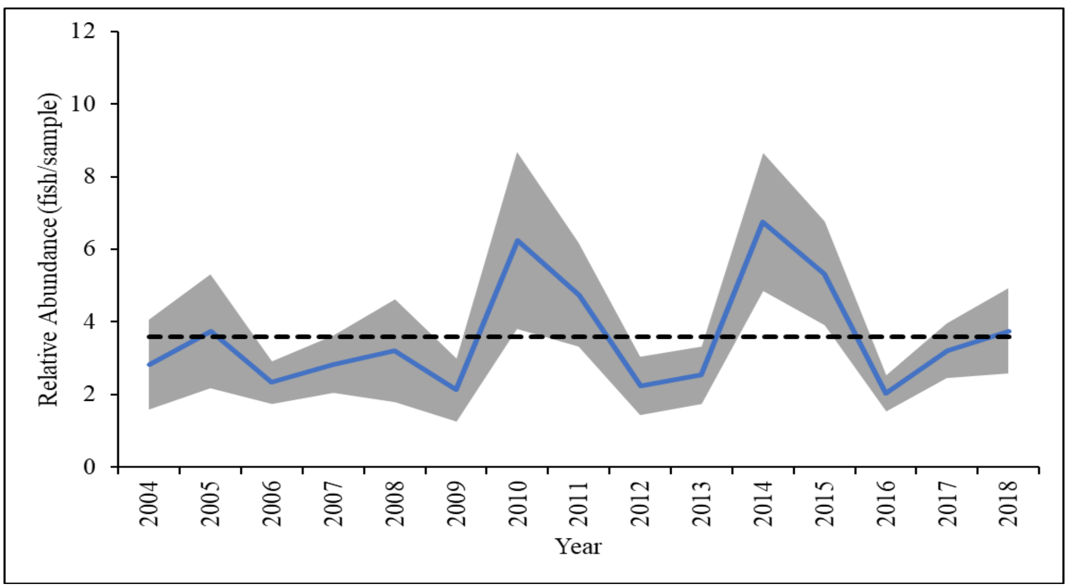

Figure 2.19. Striped bass annual weighted relative abundance index (# fish per sample; sample=240 yards of gill net) in P915, 2004–2018 (Neuse River, shallow sets, April and October–November). Dashed black line represents time-series average. Shaded area represents standard error. Soak times were not used in calculating the index.

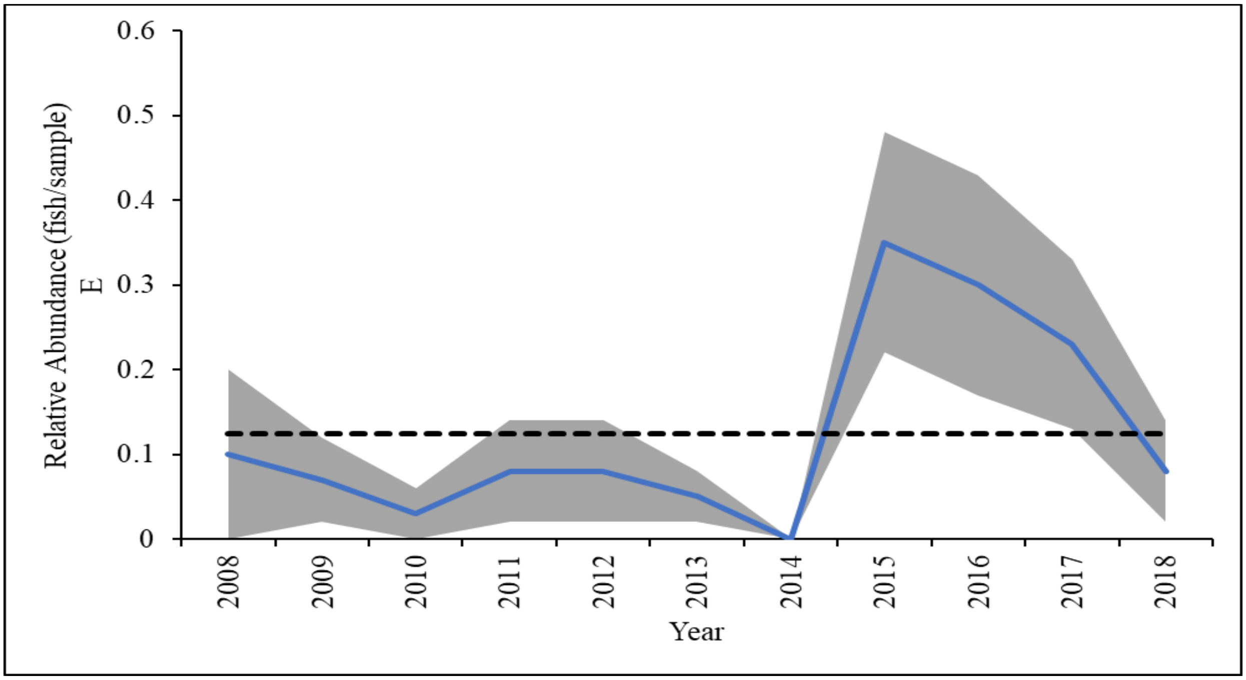

Figure 2.20. Striped bass annual weighted relative abundance index (# fish per sample; sample=240 yards of gill net) in P915, 2008–2018 (Cape Fear River, shallow sets). Dashed black line represents time-series average. Shaded area represents standard error. Soak times were not used in calculating the index.

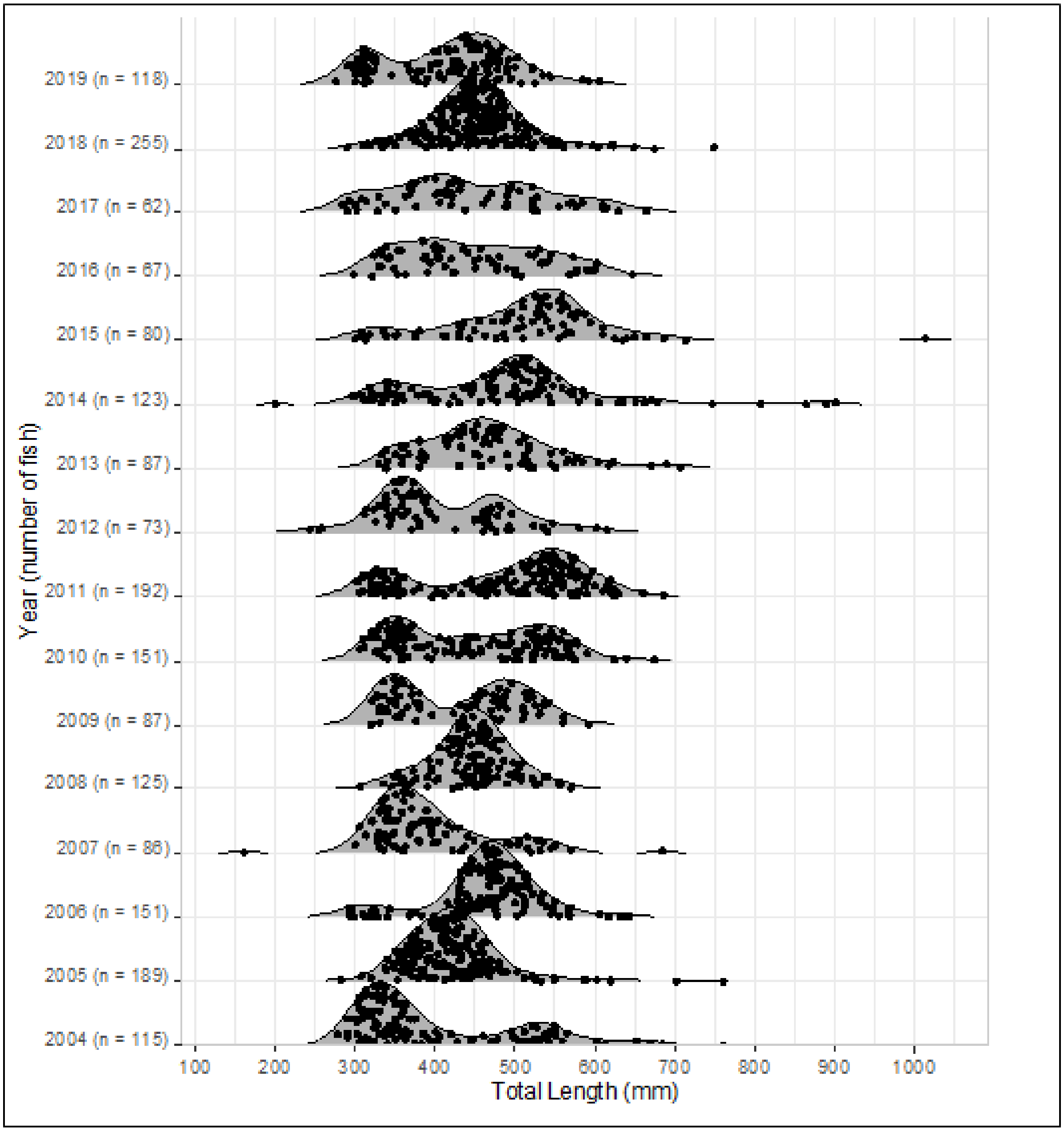

Figure 2.21. Length frequency distribution of CSMA striped bass captured in P915 in the Tar-Pamlico River, 2004–2019 (deep and shallow sets, April and October–November).

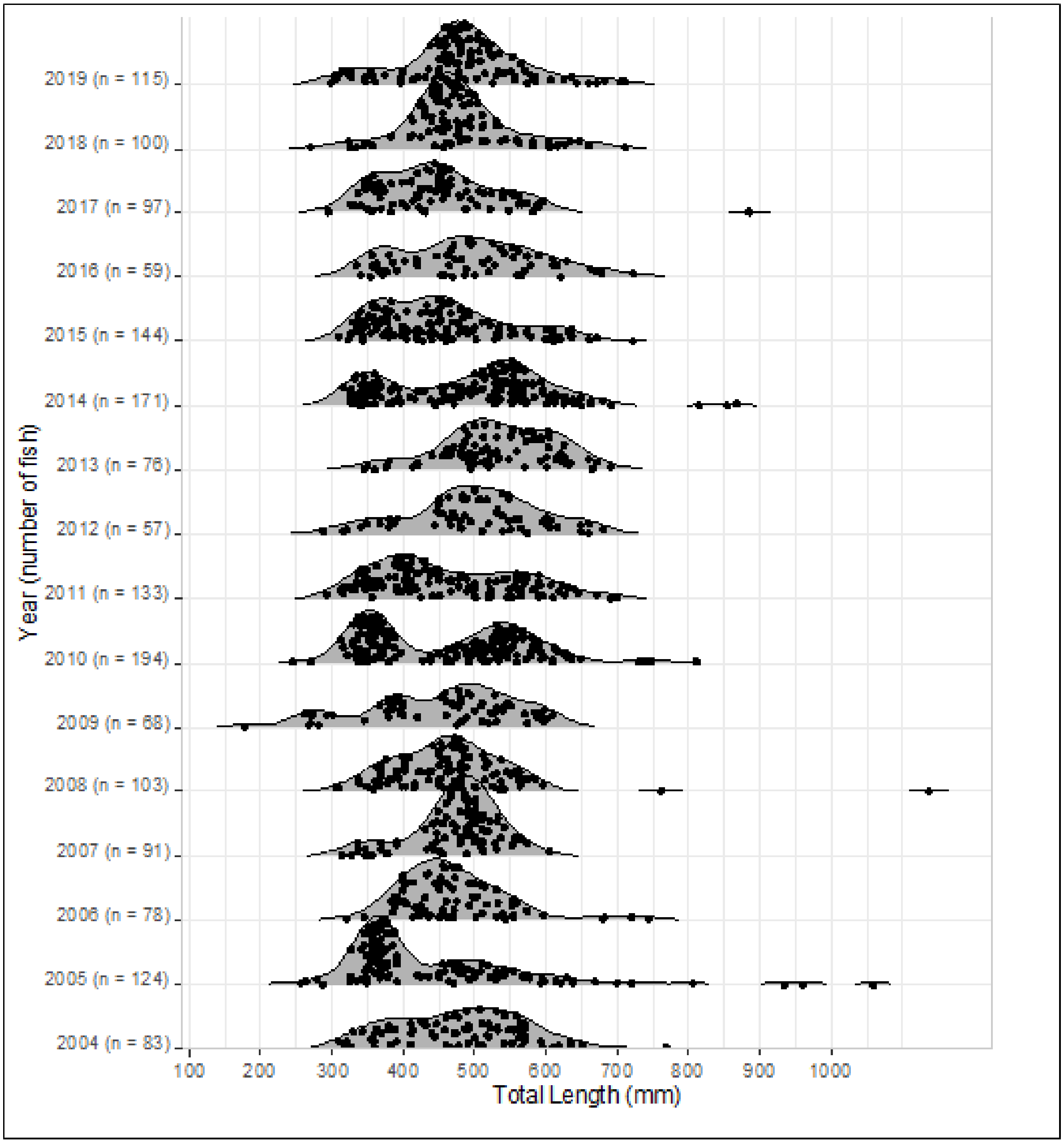

Figure 2.22. Length frequency distribution of CSMA striped bass captured in P915 the Neuse River, 2004–2019 (deep and shallow sets, April and October–November).

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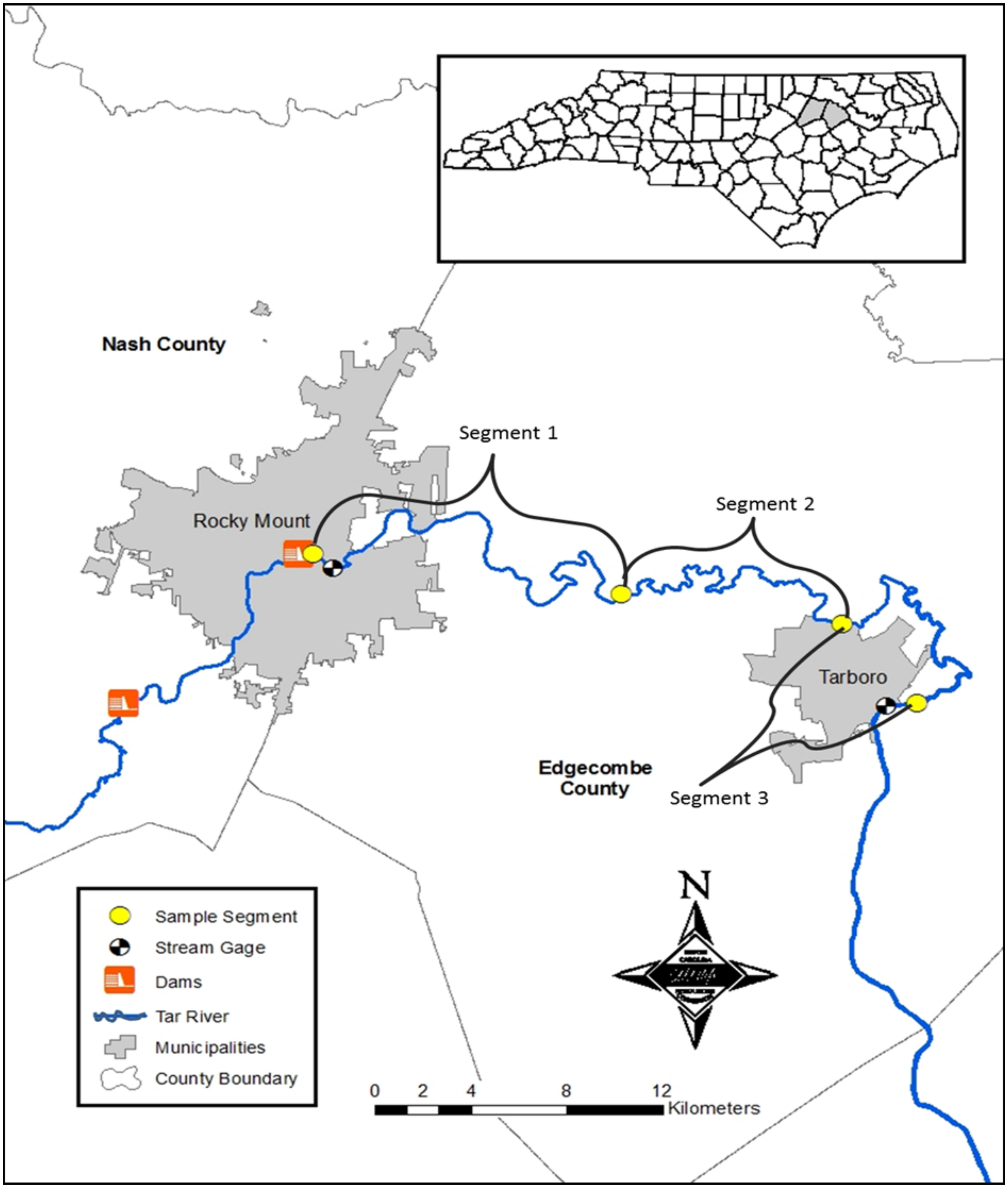

Figure 2.23. NCWRC electrofishing survey segments on the Tar-Pamlico River.

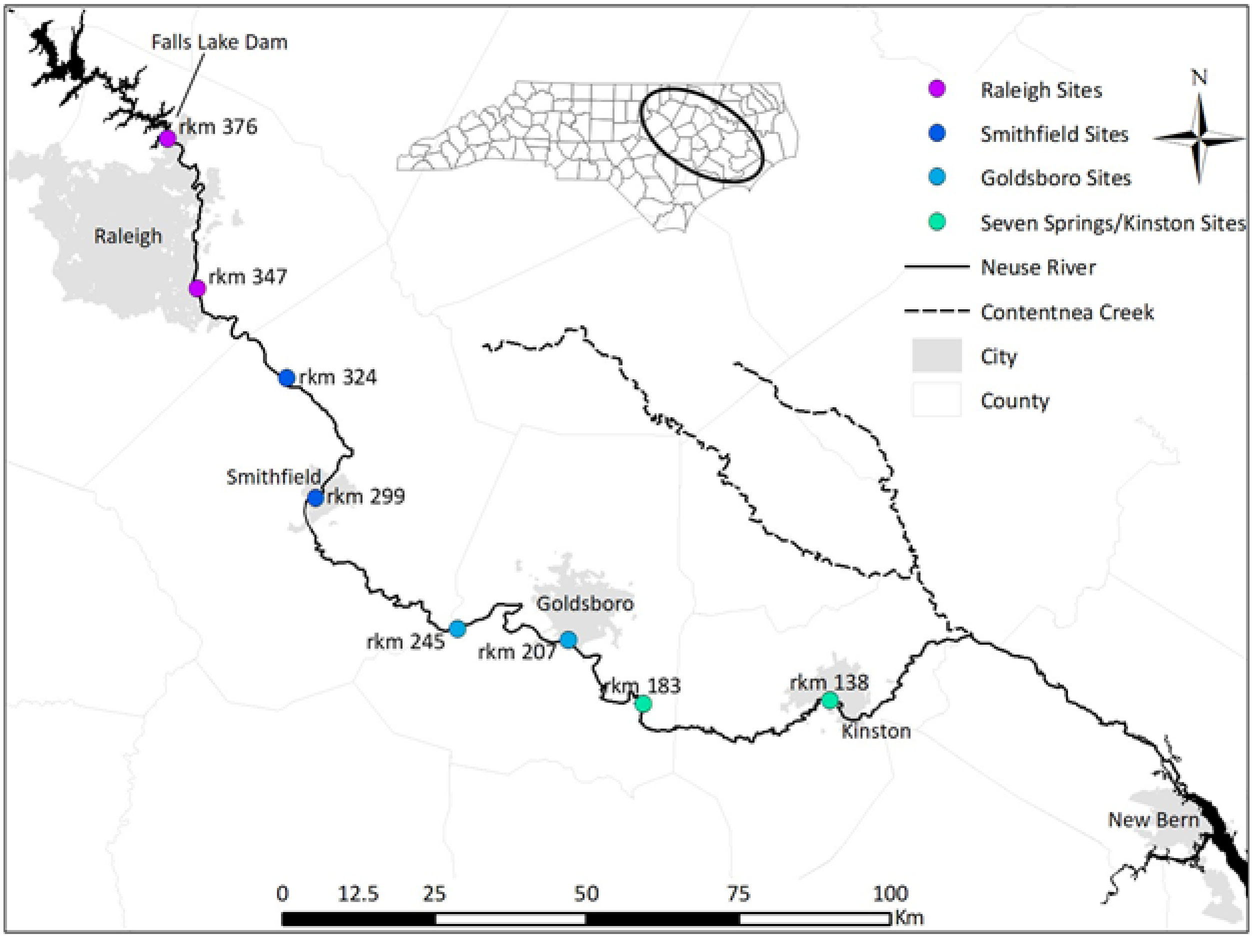

Figure 2.24. NCWRC electrofishing survey area on the Neuse River. The upstream and downstream extent of four sampling strata are by colored markers.

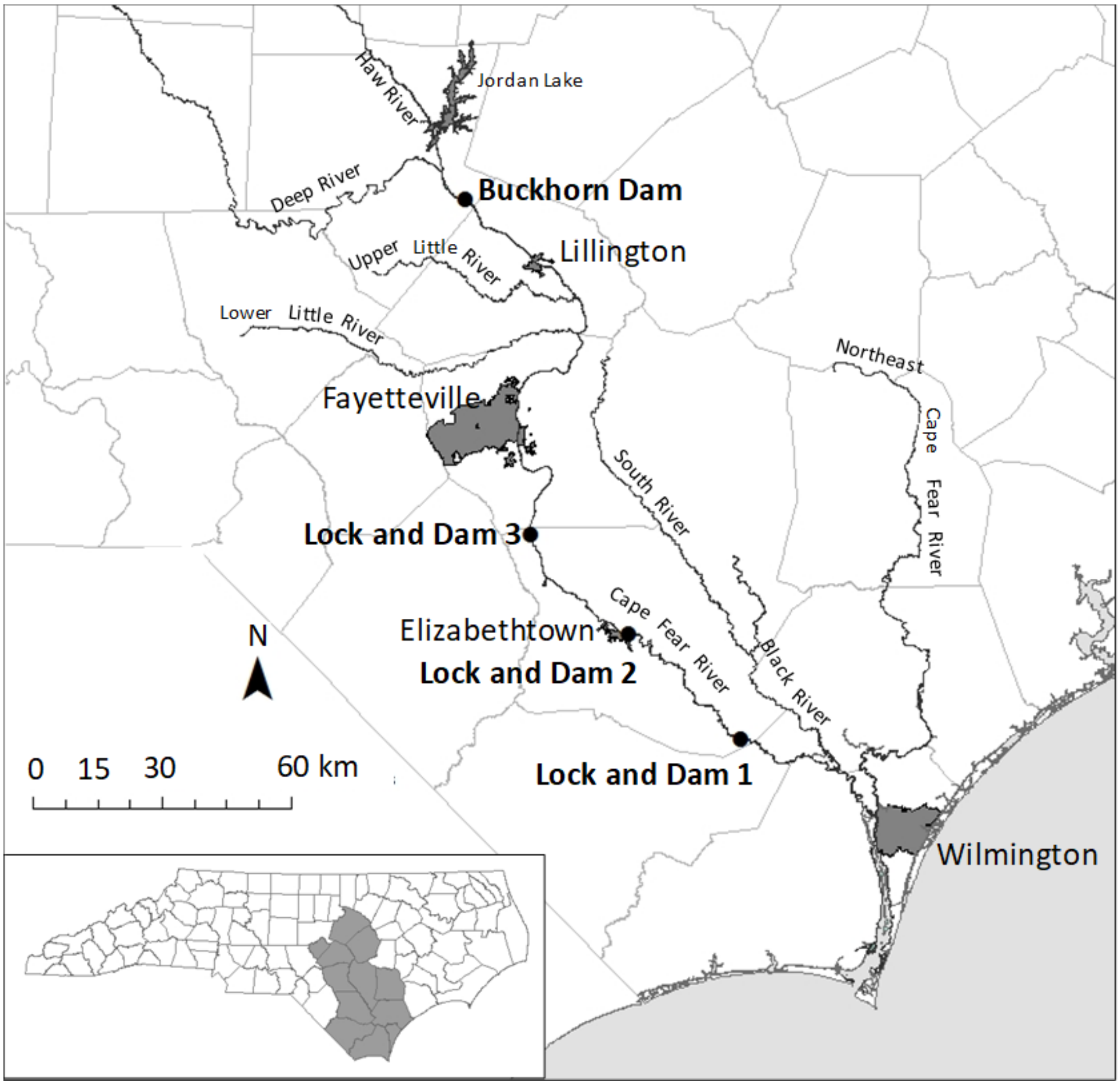

Figure 2.25. NCWRC electrofishing sampling sites (indicated by black circles in bold) at Lock and Dams 1, 2, 3, and Buckhorn Dam on the Cape Fear River.

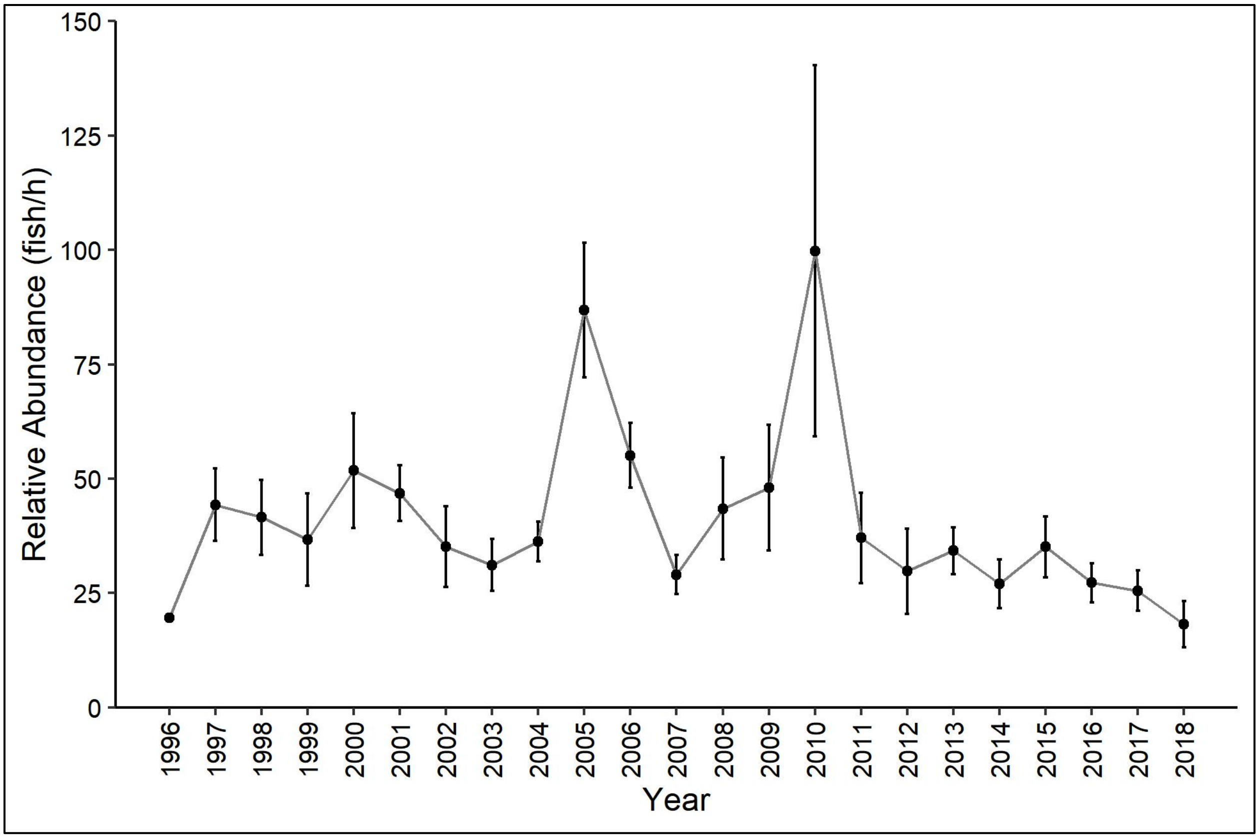

Figure 2.26. Relative abundance (with associated standard error) of striped bass collected during the NCWRC Tar River electrofishing surveys, 1996–2018.

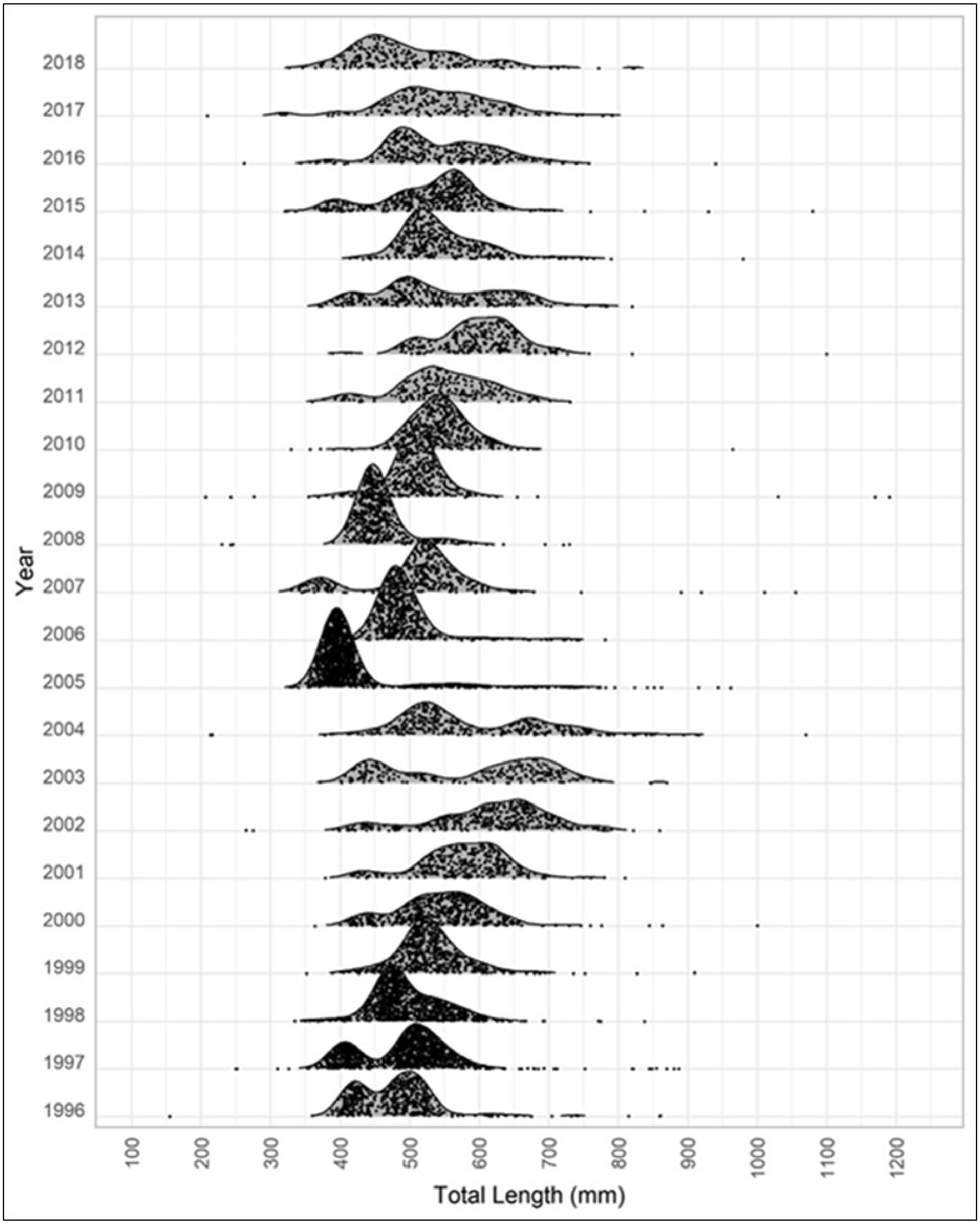

Figure 2.27. Length distributions for striped bass collected during the NCWRC Tar River electrofishing surveys, 1996–2018. Dots indicate individual length measurements.

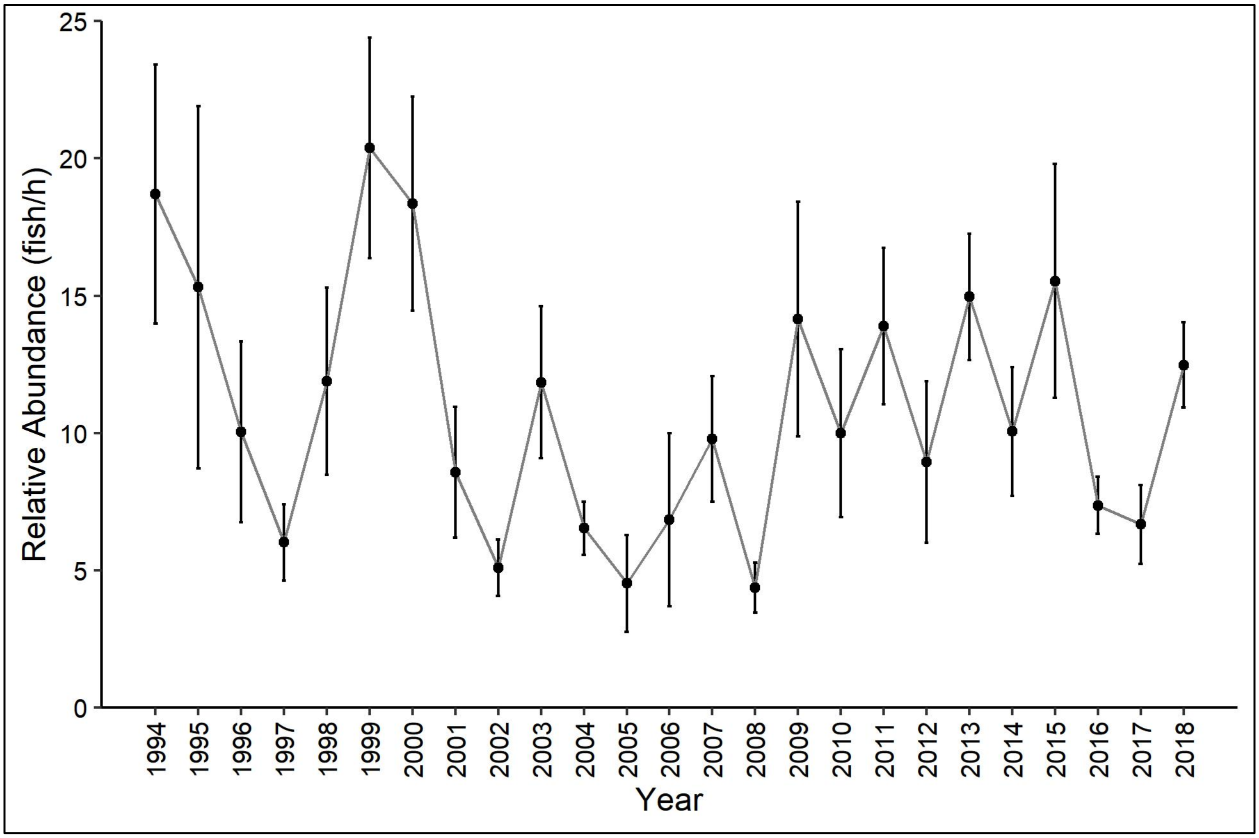

Figure 2.28. Relative abundance (with associated standard error) of striped bass collected during the NCWRC Neuse River electrofishing surveys, 1994–2018.

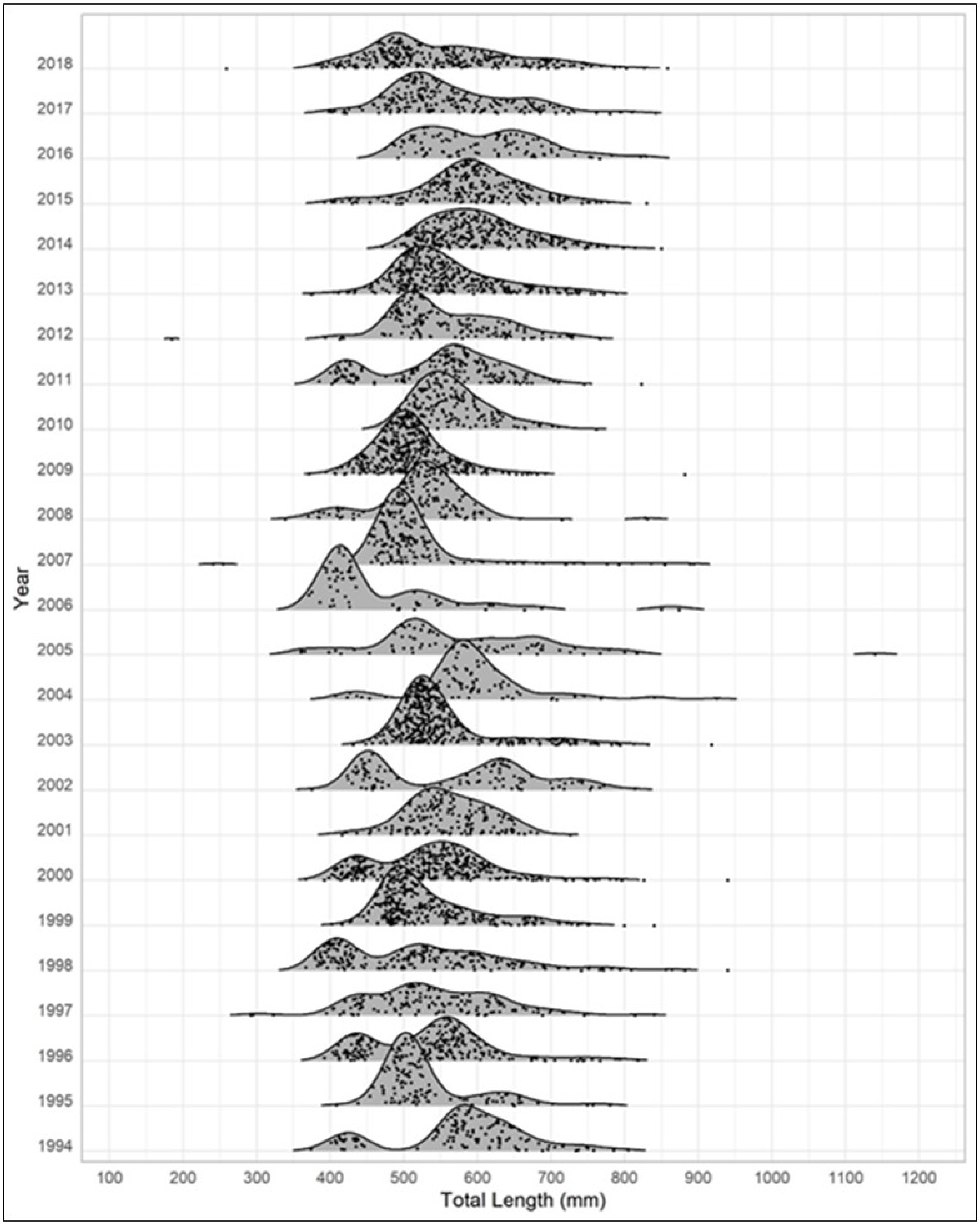

Figure 2.29. Striped bass length distributions for the NCWRC Neuse River electrofishing surveys, 1994–2018. Dots indicate individual length measurements.

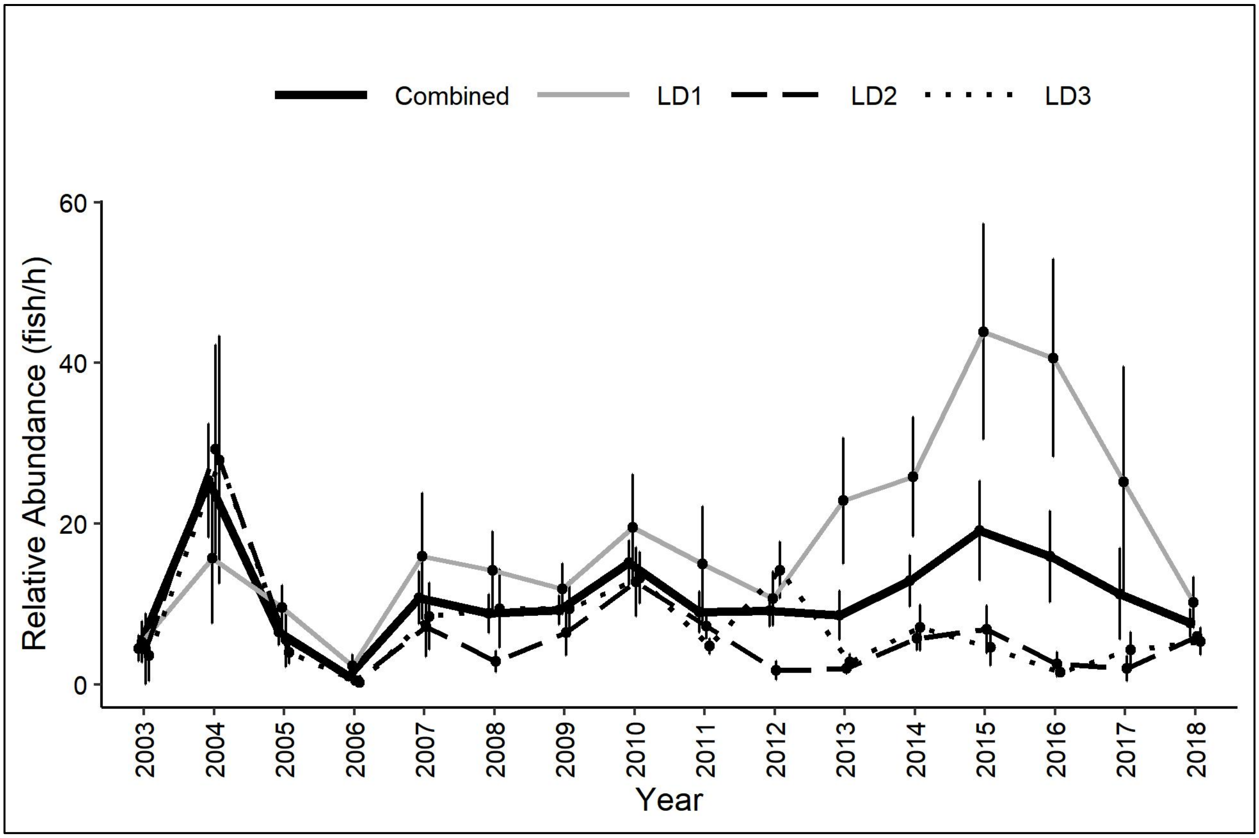

Figure 2.30. Relative abundance (with associated standard error) of striped bass collected at three sample sites in the Cape Fear River, NC, 2003–2018.

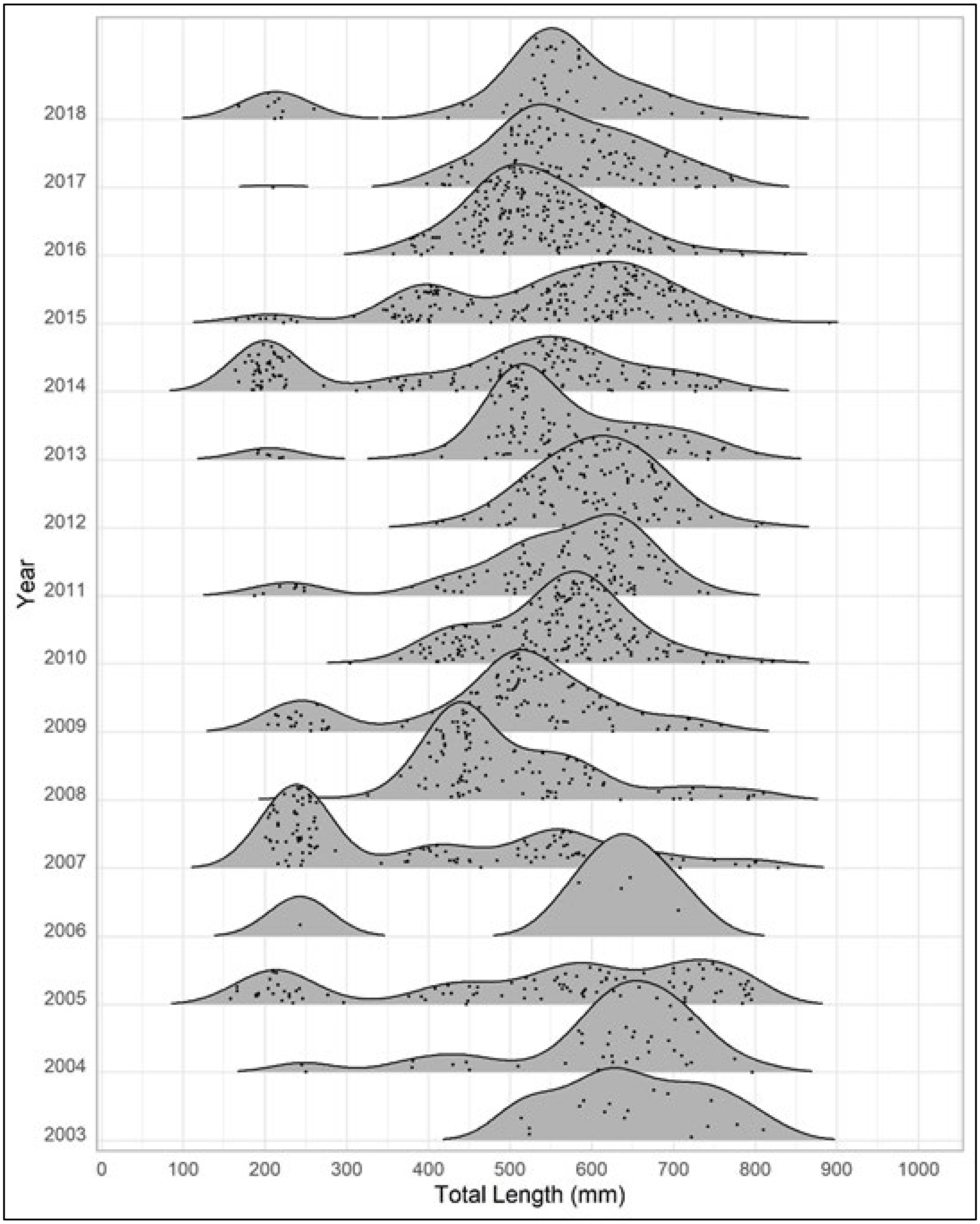

Figure 2.31. Length distributions for striped bass collected during the NCWRC Cape Fear River electrofishing surveys, 2003–2018. Dots indicate individual length measurements.

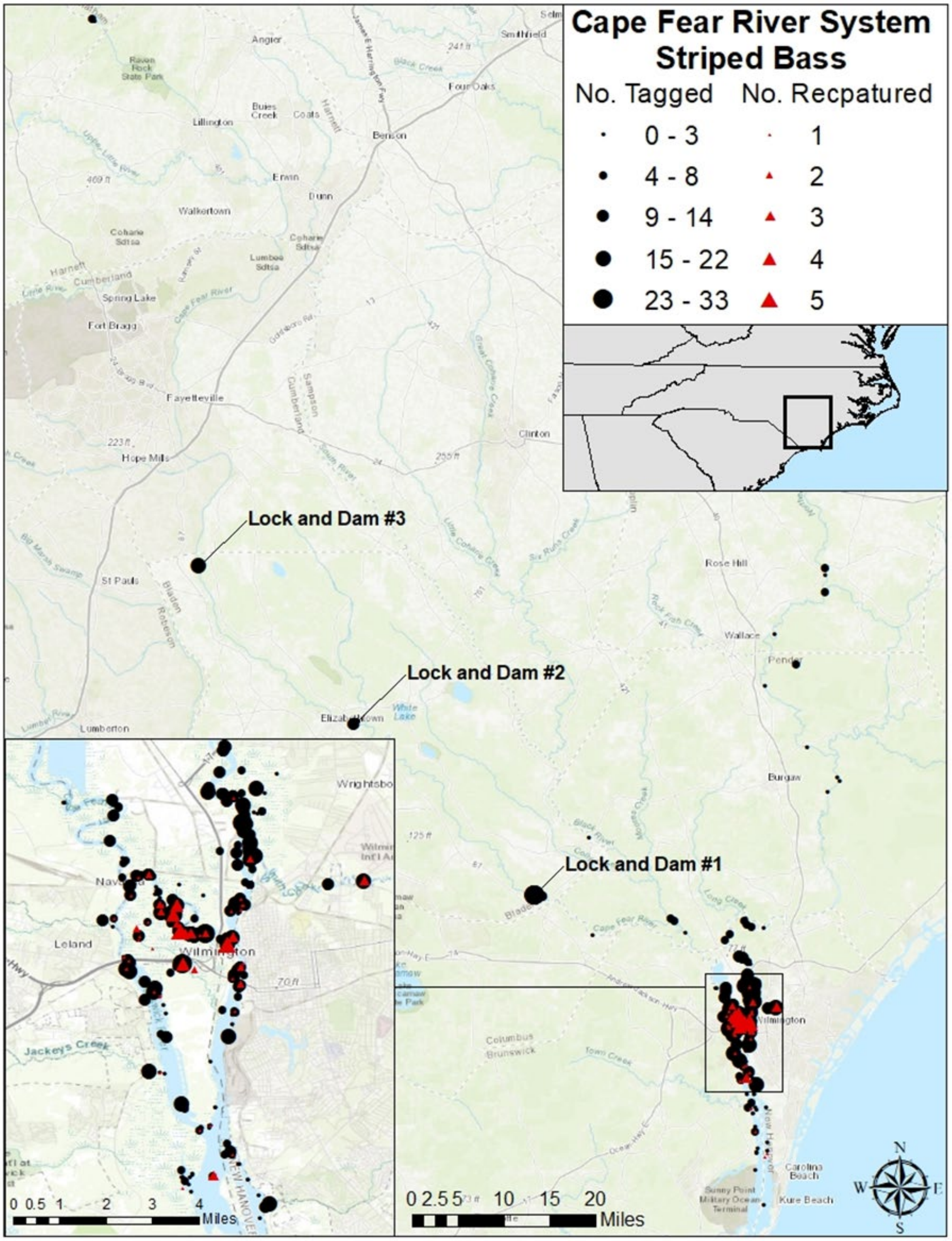

Figure 2.32. Cape Fear River striped bass tagging and recapture locations, 2012–2018.

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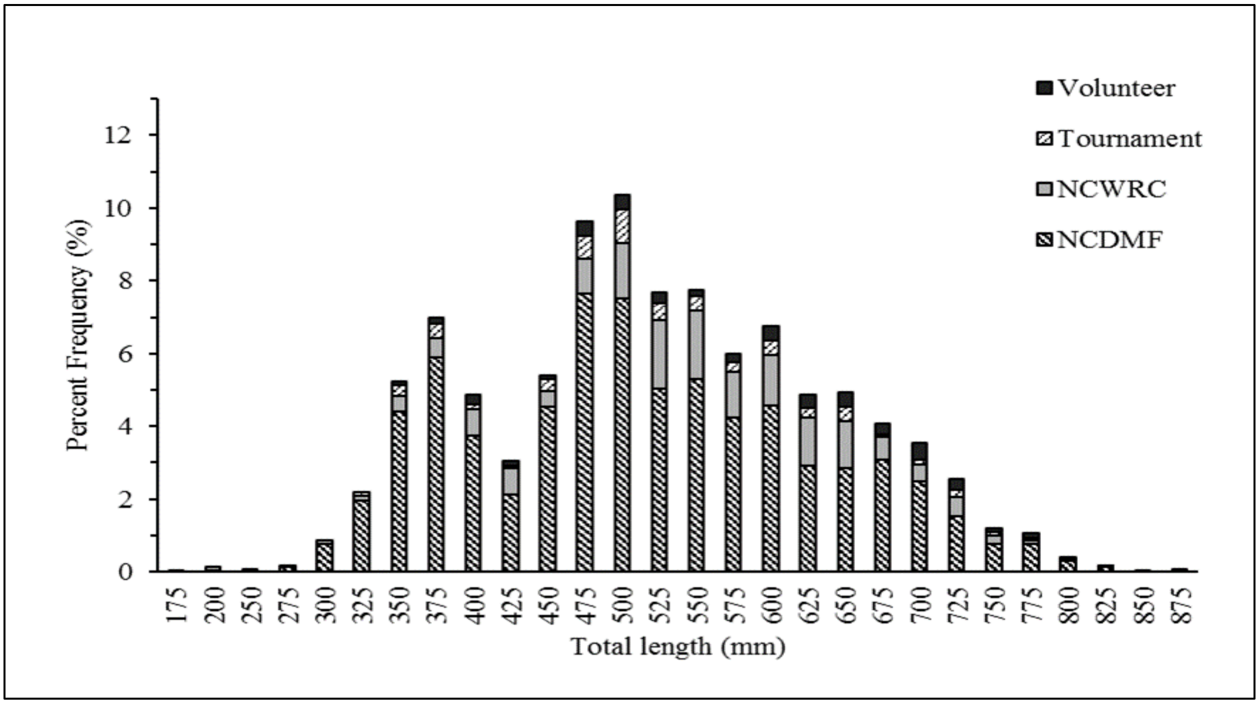

Figure 2.33. Length-frequency distribution of tagged striped bass included in the tagging model by tagger affiliation in the Cape Fear River, 2012–2018.

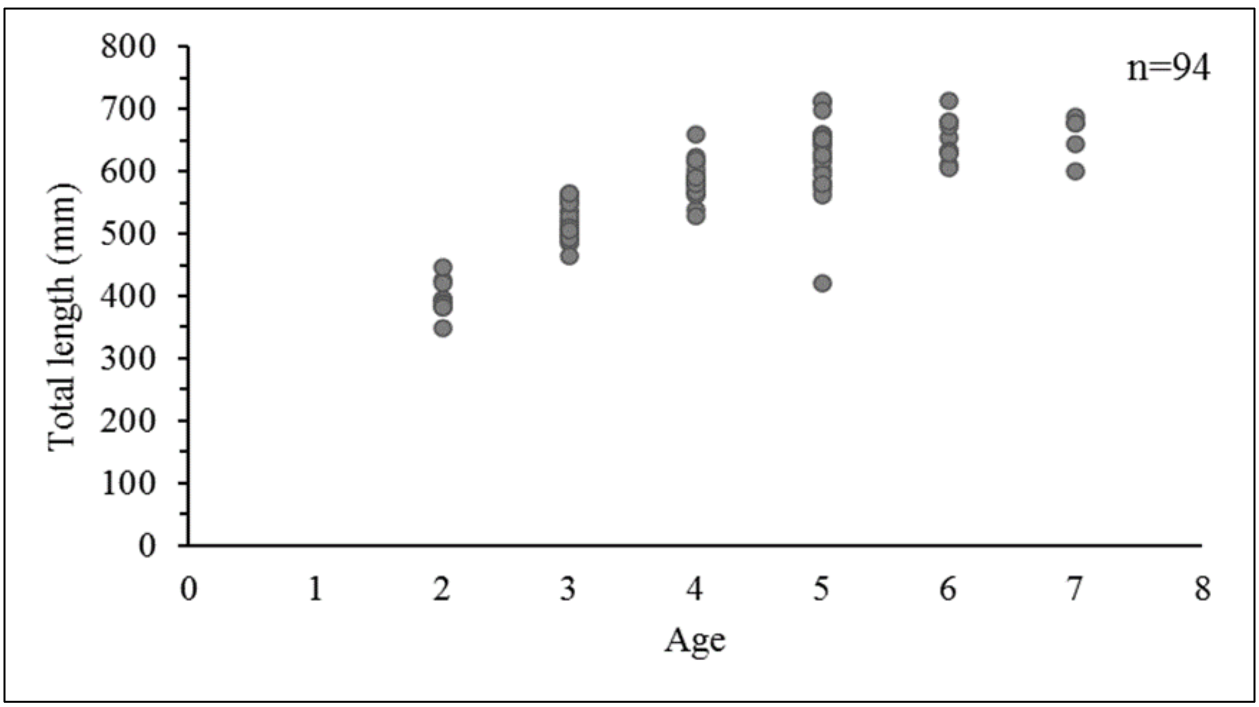

Figure 2.34. Genetically derived age at length of Cape Fear River striped bass, 2016–2017.

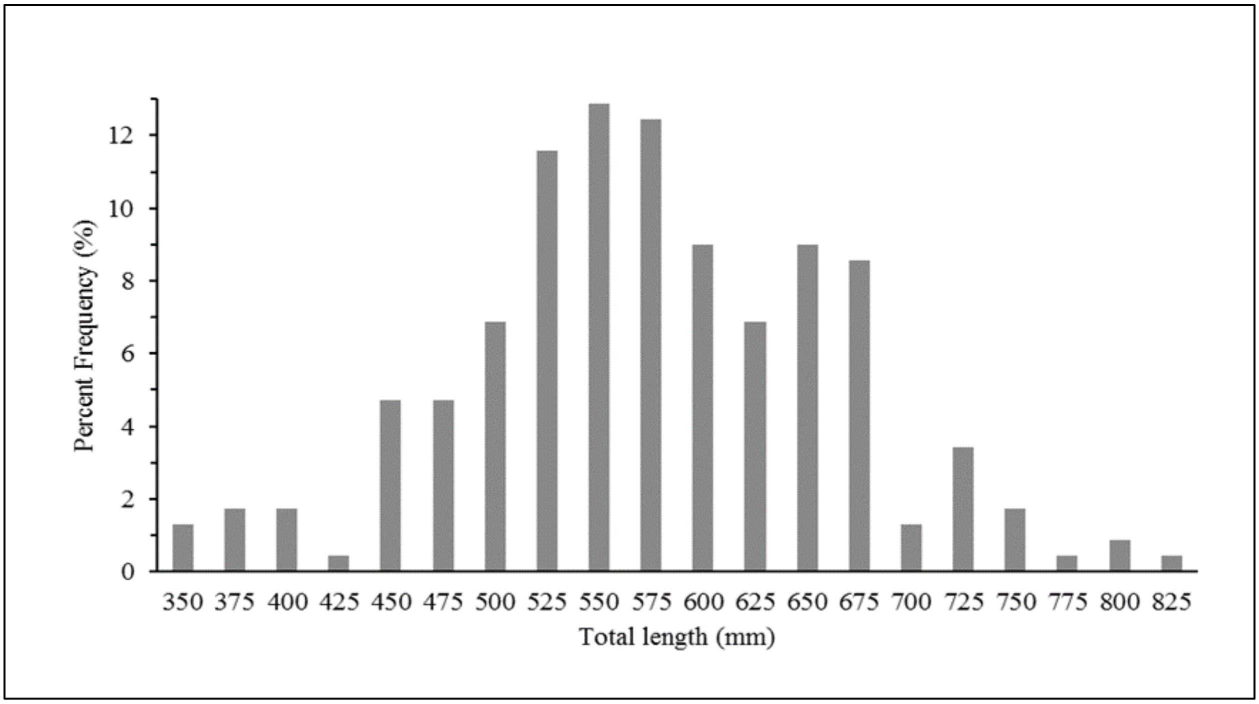

Figure 2.35. Length-frequency distribution of recaptured striped bass included in the tagging model by tagger affiliation in the Cape Fear River, 2012–2018.

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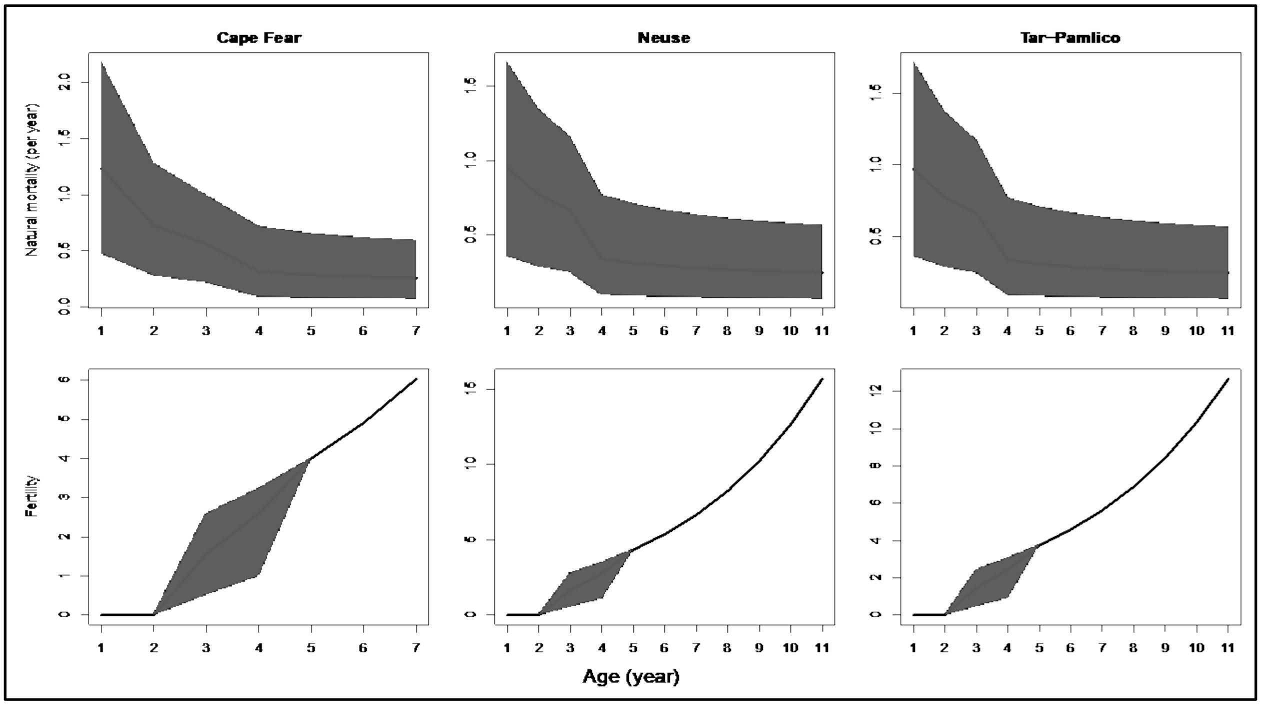

Figure 3.1. Age-specific natural mortality and fertility used in the matrix model. Black line is median and grey area is 95% confidence interval.

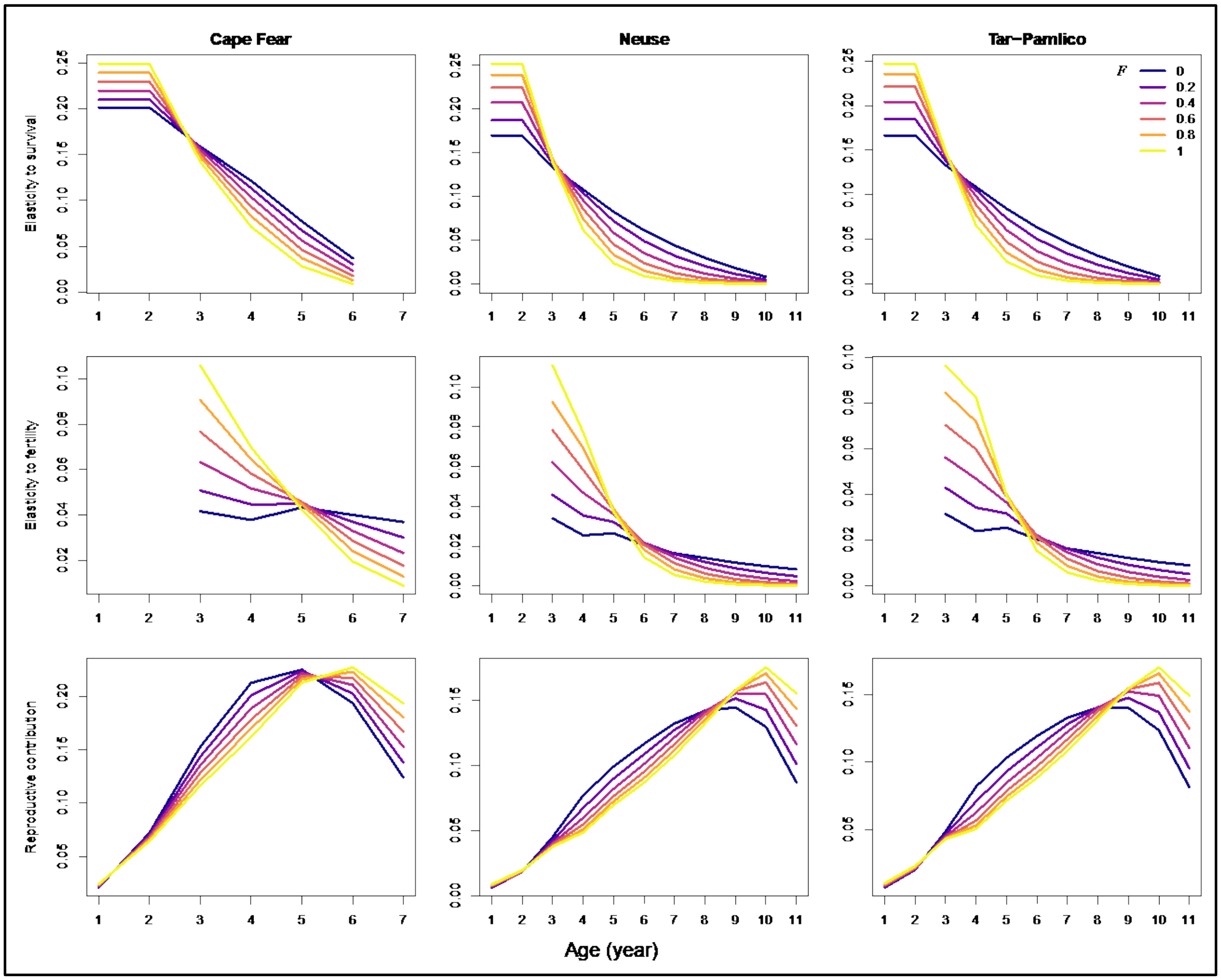

Figure 3.2. Elasticity of population growth rate to survival and fertility and age-specific reproduction contribution. Lines represent various fishing mortality (F) values. Lines show the median from 10,000 iterations.

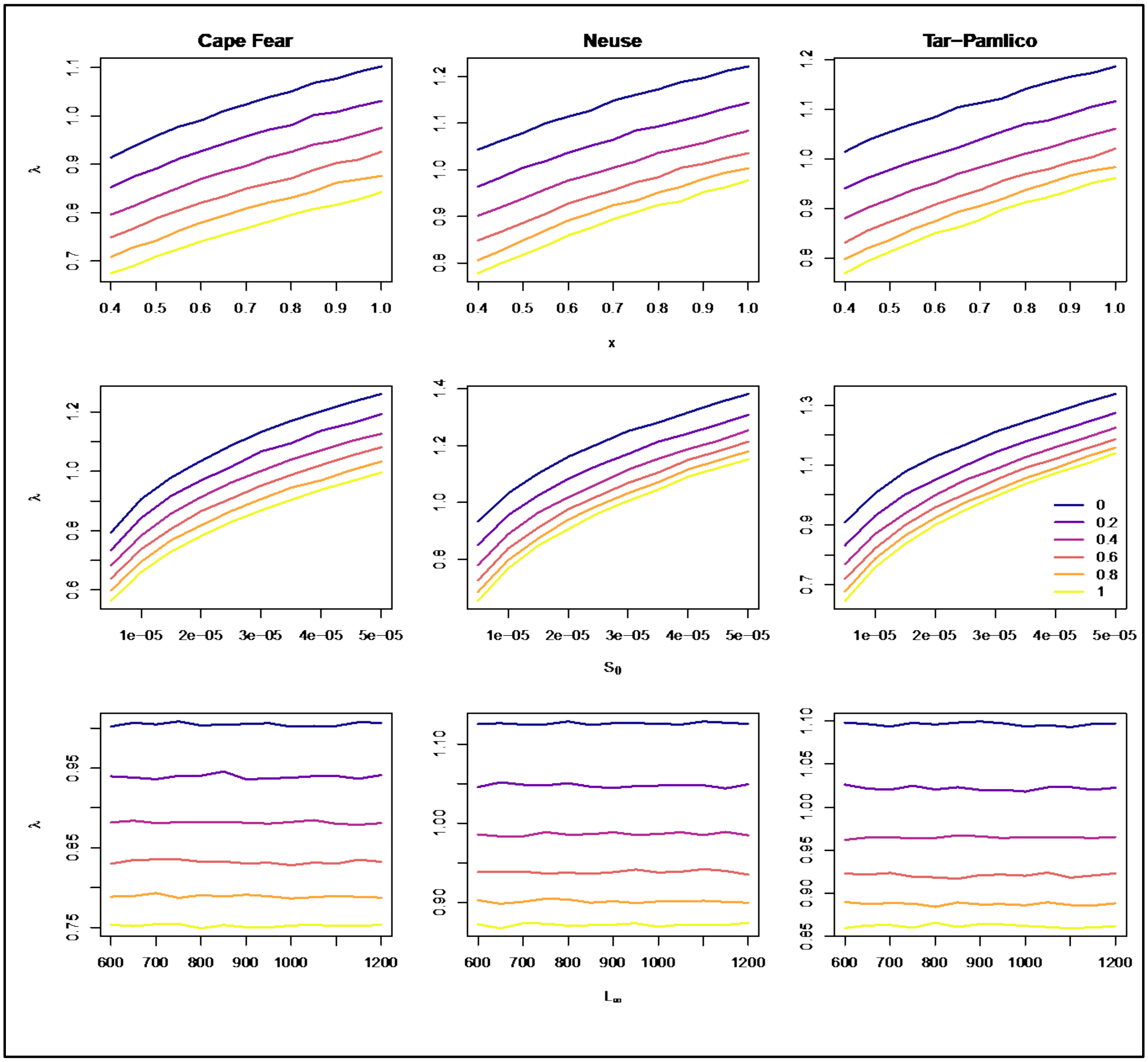

Figure 3.3. Sensitivity of population growth rate to viable egg proportion (*x*), age-0 survival (S_0) and the asymptotic length (L_∞). Lines represent various fishing mortality (*F*) values. Lines show the median from 10,000 iterations.

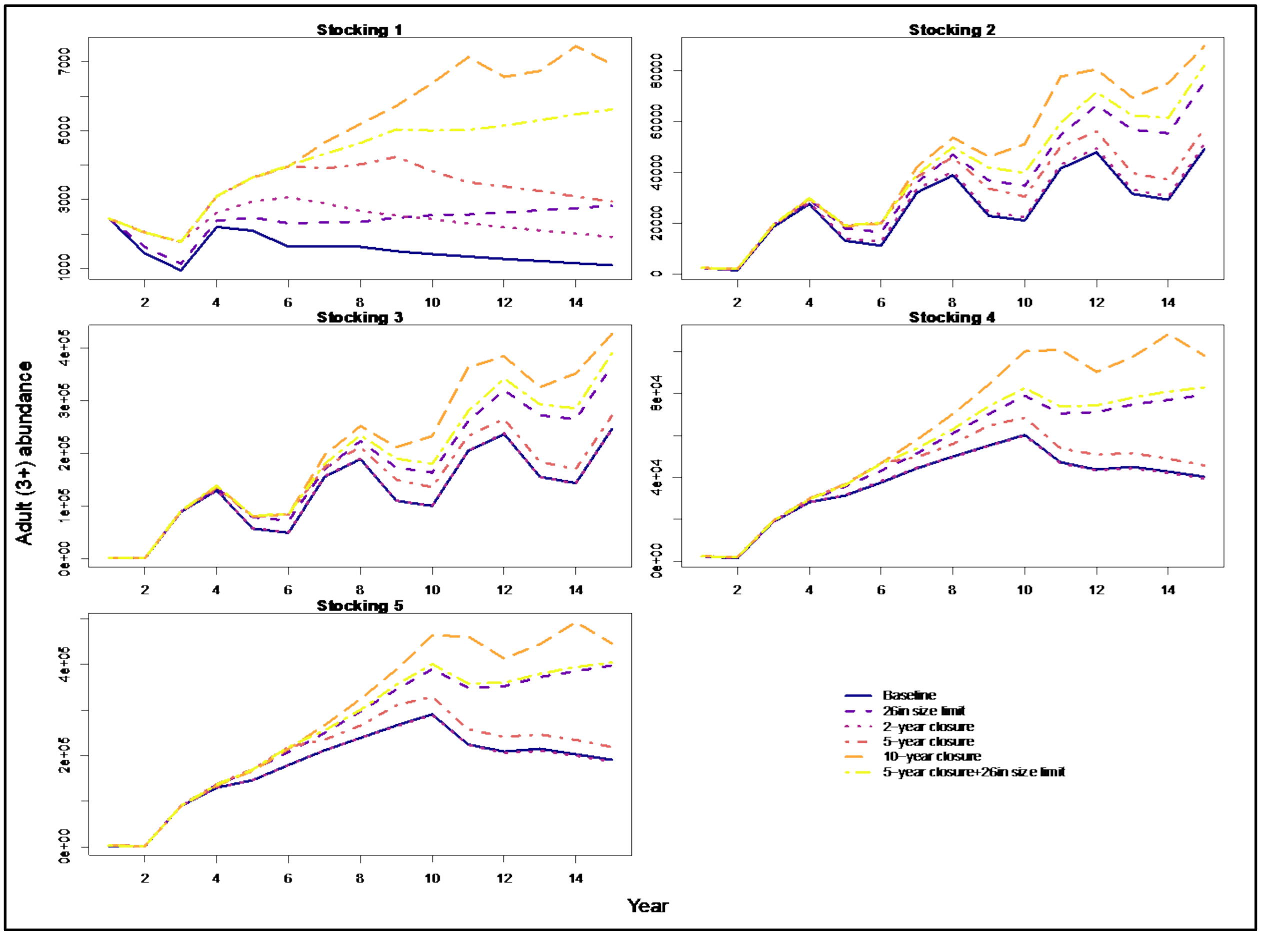

Figure 3.4. Abundance of adults (age 3+) projected under five stocking strategies and six fishing strategies. Stocking 1—no stocking; Stocking 2—stocking 100,000 fish per year with 2-year stocking and 2-year no stocking alternating for 15 years (8 years of stocking in total); Stocking 3—stocking 500,000 fish per year with 2-year stocking and 2-year no stocking alternating for 15 years (8 years of stocking in total); Stocking 4—stocking 100,000 fish per year with 8-year continuous stocking; Stocking 5—stocking 500,000 fish per year with 8-year continuous stocking. Lines show the median from 10,000 iterations.

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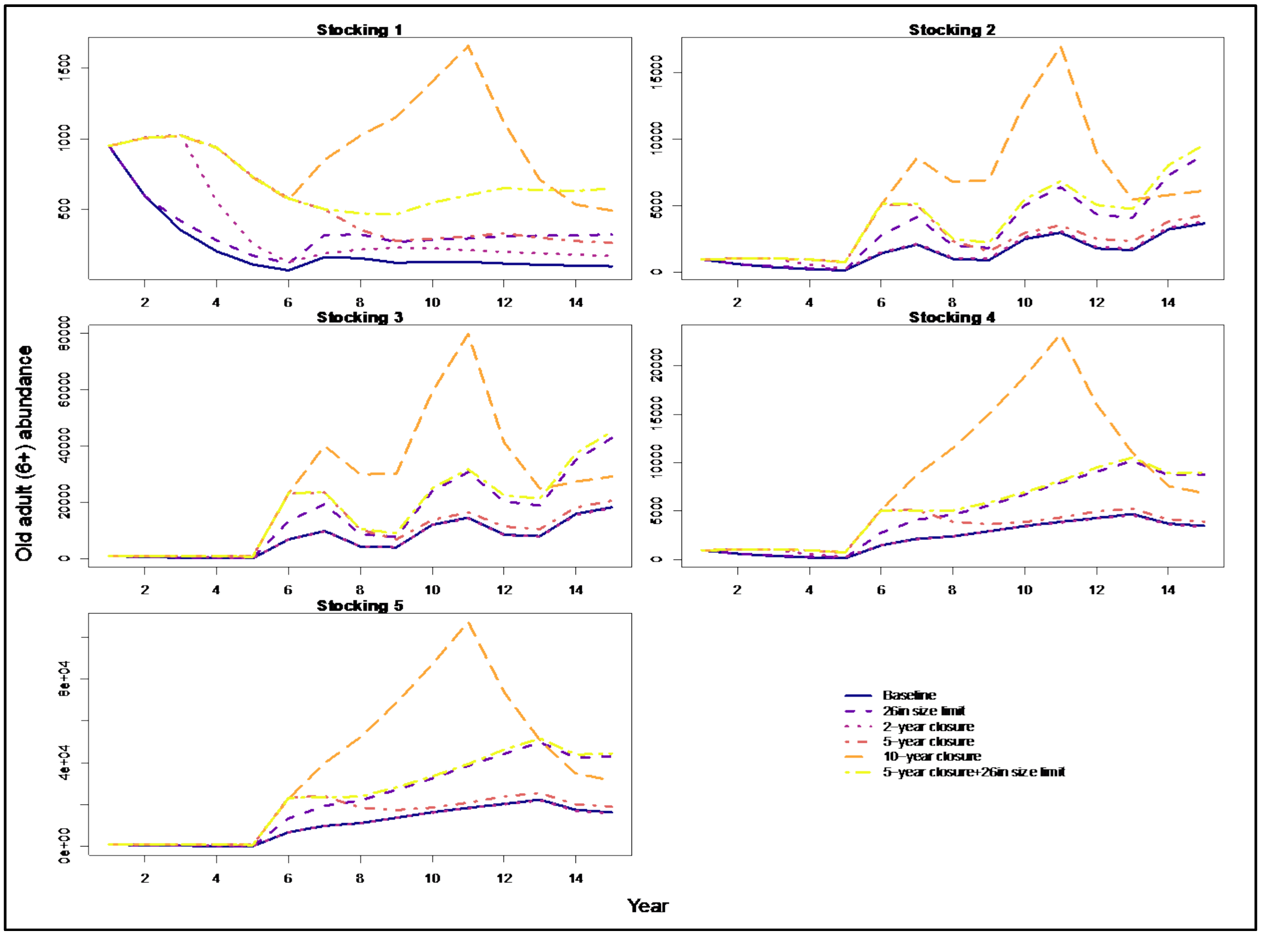

Figure 3.5. Abundance of old adults (age 6+) projected under five stocking strategies and six fishing strategies. Lines show the median from 10,000 iterations. See Figure 3.4 caption for explanation of the five stocking strategies.

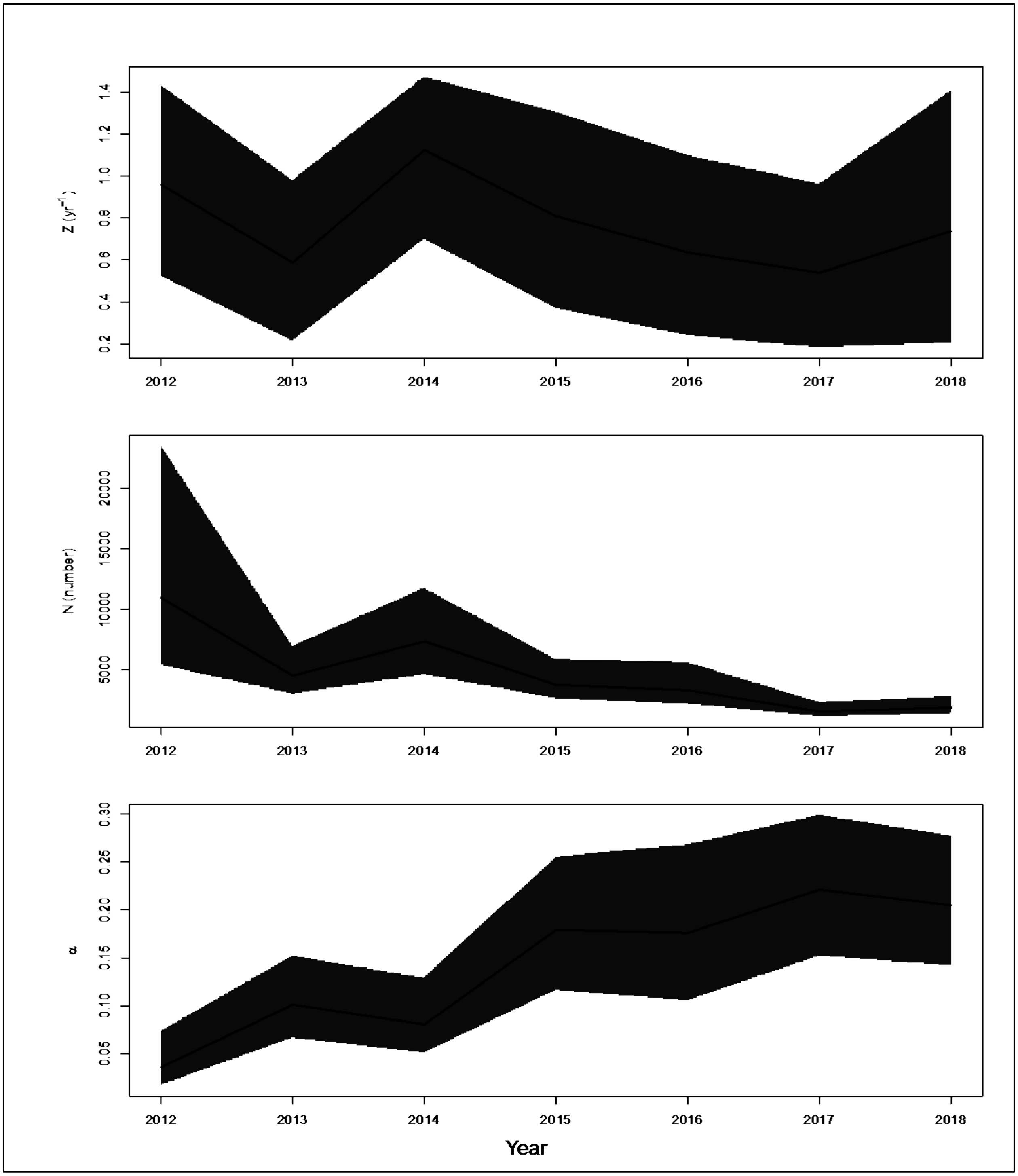

Figure 4.1. Estimated instantaneous total mortality (Z, yr^{-1}) due to natural causes and fishing, estimated abundance (N, number) and estimated capture probability (α) from the tagging model. Line is posterior median and shaded area is 95% credible interval.

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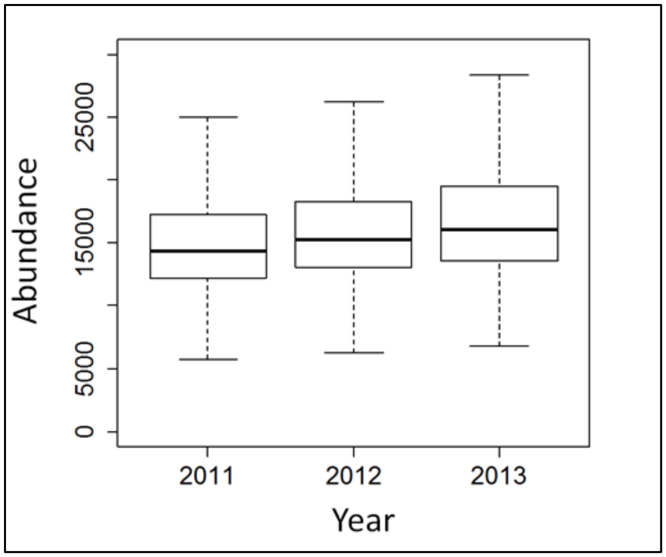


Figure 4.2. Posterior distributions of annual abundance estimated using a Jolly-Seber model and capture probabilities estimated by the multistate model in the Cape Fear River. The whiskers of the boxplots indicate 95% credible intervals of the estimates; boxes of the boxplots represent 50% credible intervals and the bolded lines of each boxplot represent abundance estimates. (Source: Collier et al. 2013)

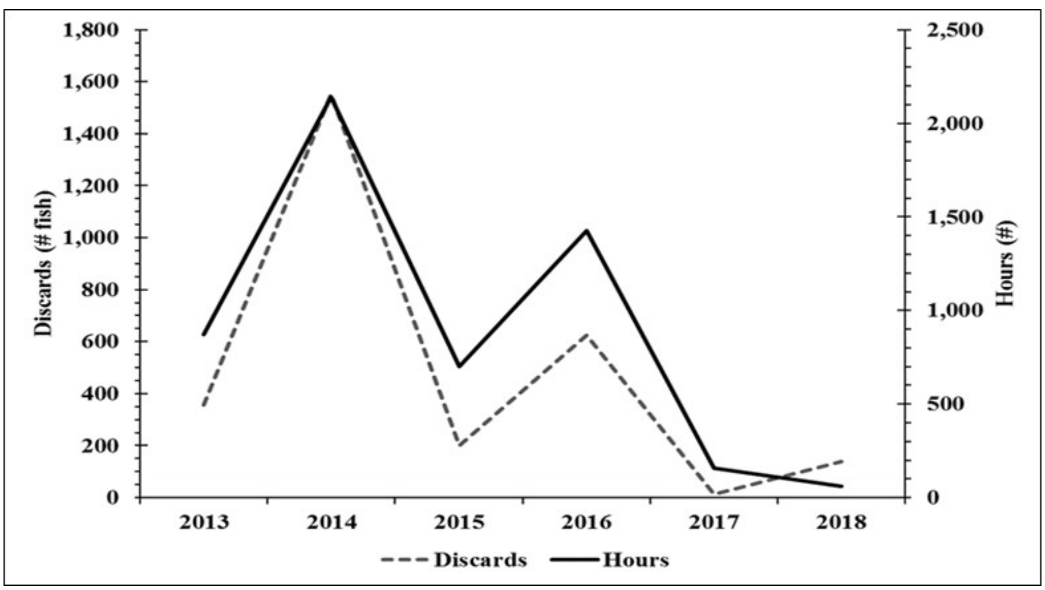
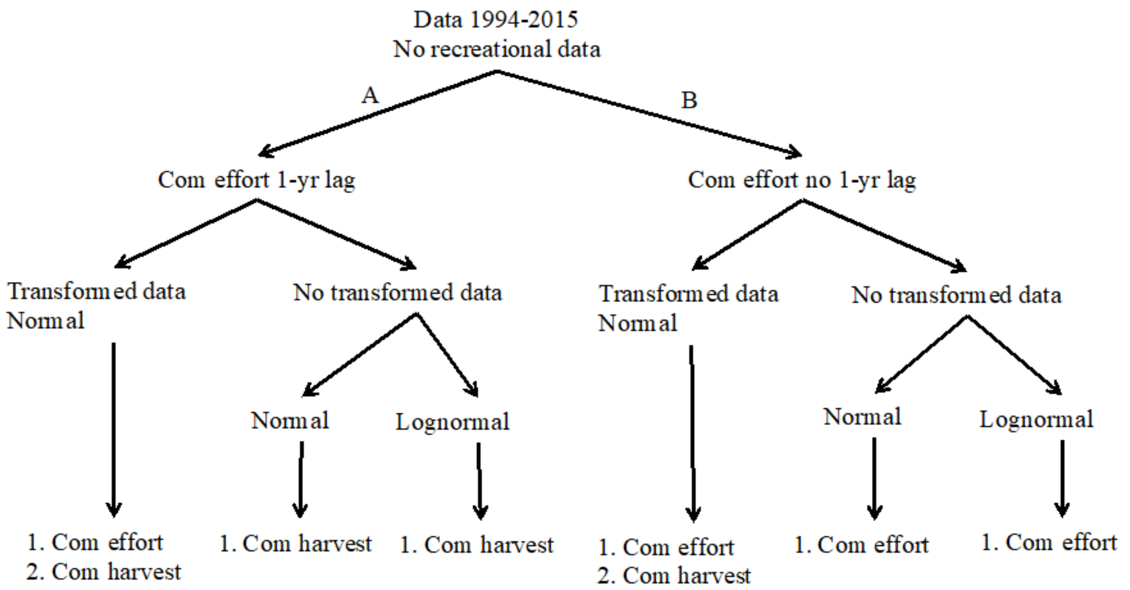


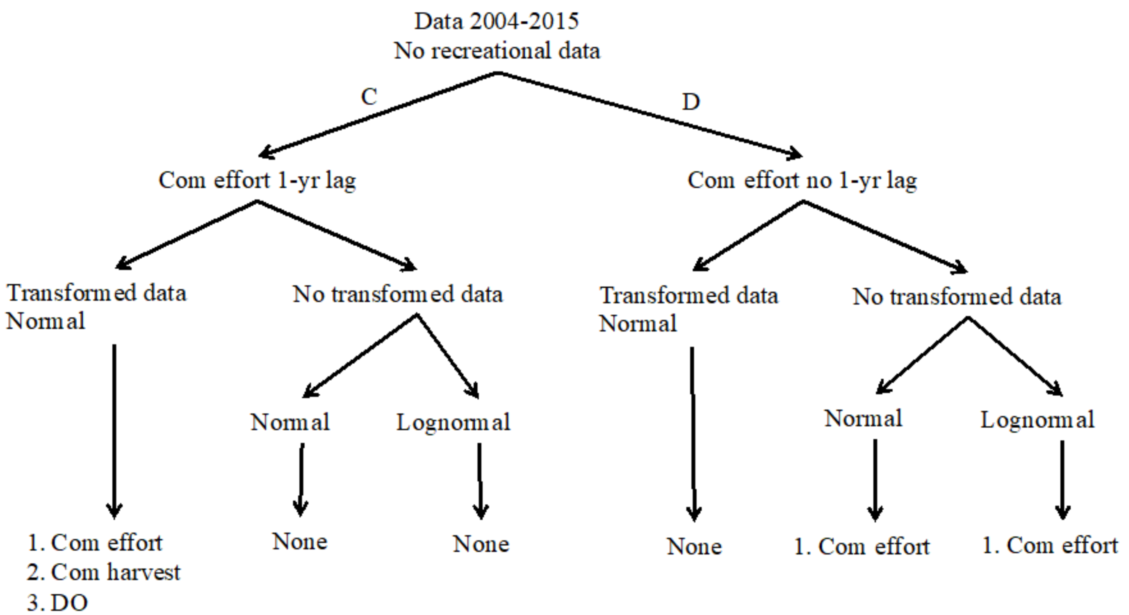
Figure 4.3. NCDMF recreational creel survey estimated striped bass discards (number; dotted line) and recreational fishing effort (hours; solid line) in the Cape Fear River, 2013–2018. In 2013, due to comparatively low recreational striped bass catch, American and hickory shad became the target species.

Figure 4.4. Dead striped bass at Battleship Park, Wilmington, NC following extensive flooding from Hurricane Florence in September 2018.

(A)



(B)



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(C)

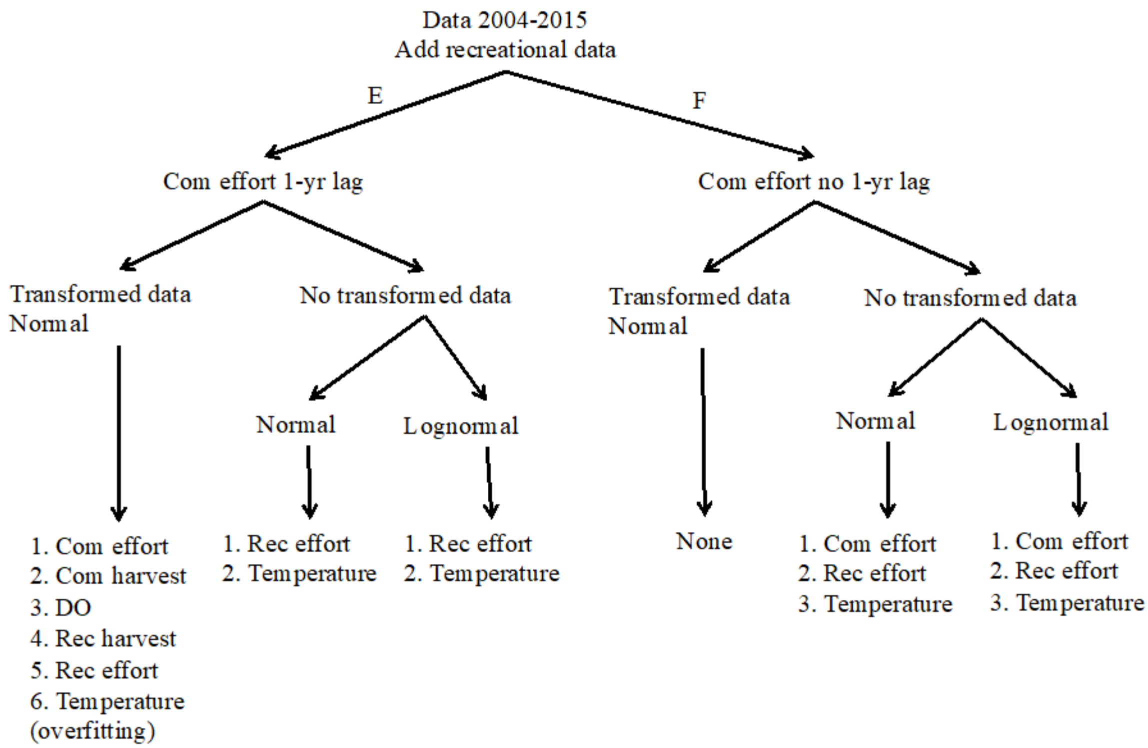

Figure 5.1. Important factors selected in the model when using data from (A) 1994–2015, and (B) data from 2004–2015 without considering recreational information, and (C) when using data from 2004–2015 with recreational information included. These factors are listed in the order of importance from the most important to the least important ones. See the caption of Table 1 for abbreviations of the predictor variables.

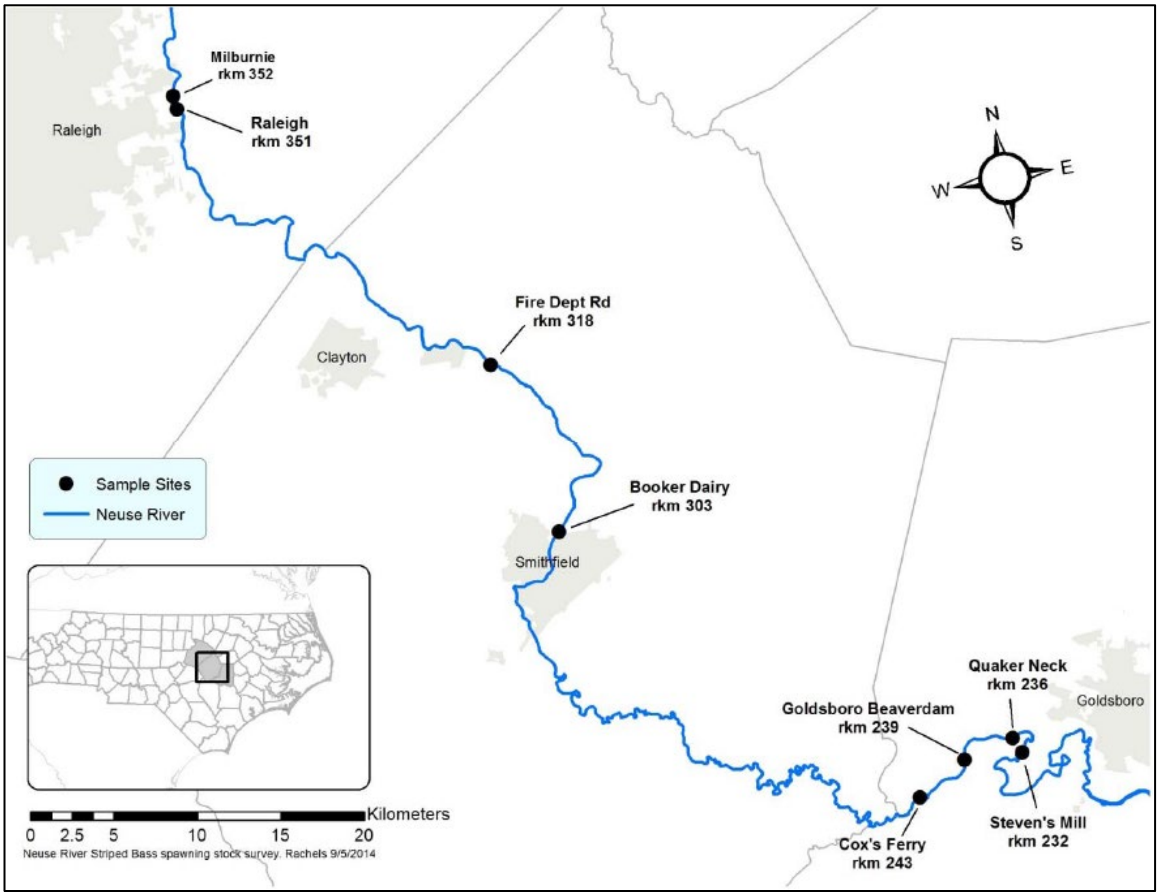

Figure 6.1. Sampling sites in the Neuse River for the NCWRC's Spawning Stock Survey.

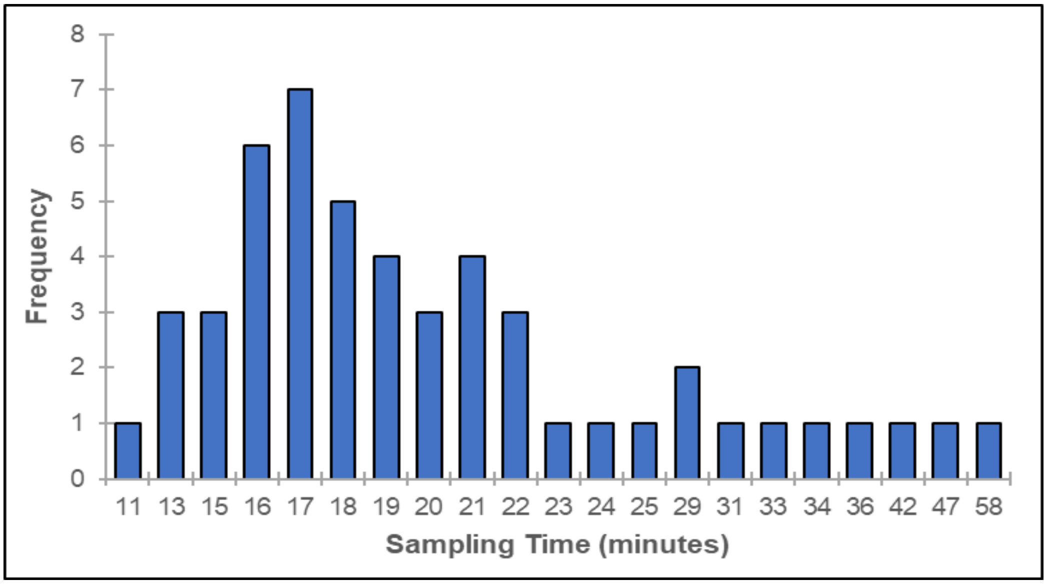

Figure 6.2. Range of sampling times for individual sampling trips from the NCWRC's Spawning Stock Survey in 2017.

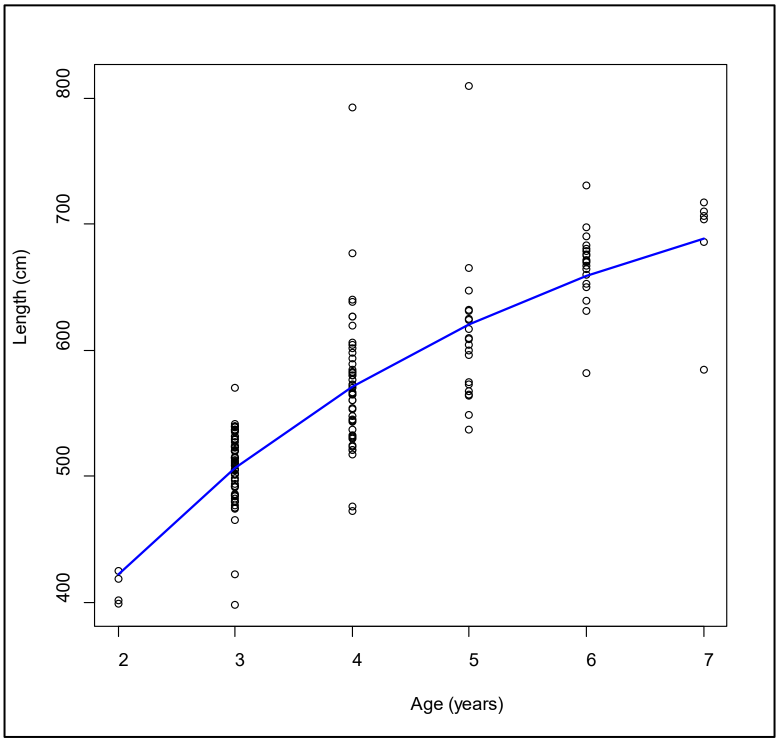

Figure 6.3. Observed (black circles) and predicted (blue line) values of the von Bertalanffy age-length relationship.

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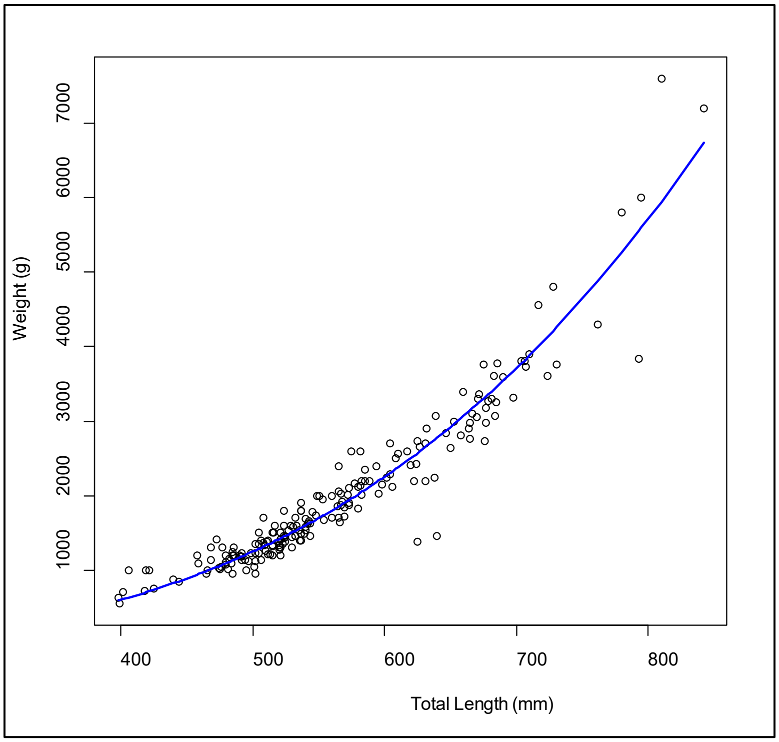

Figure 6.4. Observed (open black circles) and predicted (blue line) values of the length-weight relationship.

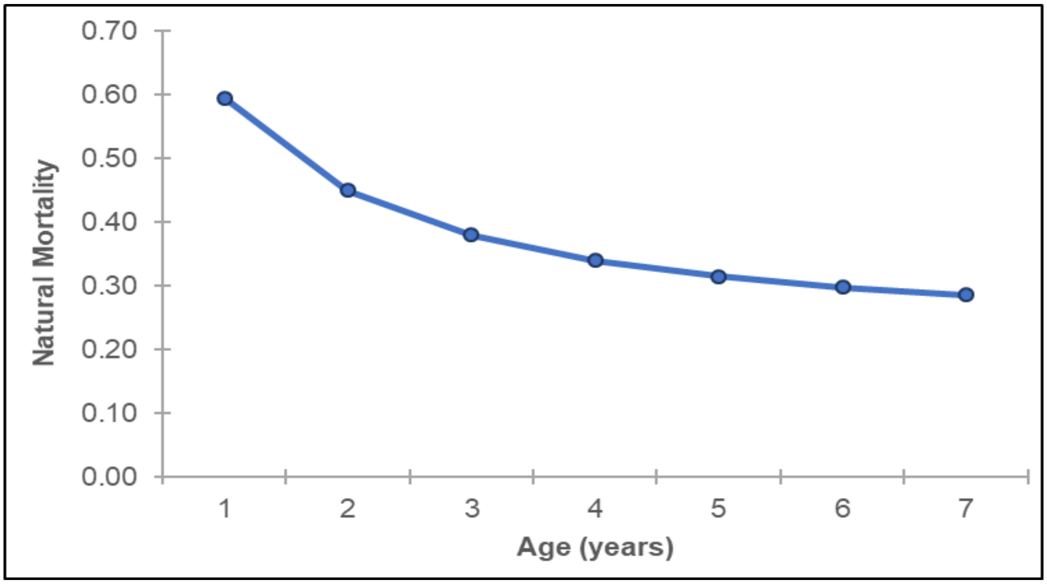

Figure 6.5. Estimated natural mortality at age based on Lorenzen's (1996) approach. The values shown represent instantaneous rates.

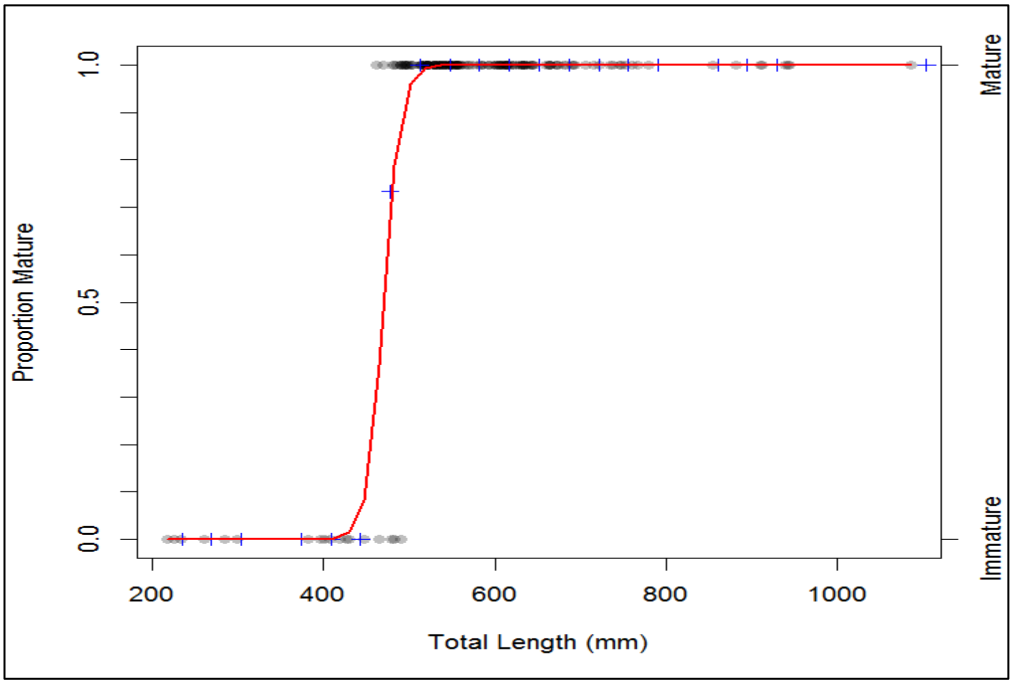

Figure 6.6. Observed (grey circles) and predicted (red line) values of the length-maturity relationship. The blue plus signs represent the proportion mature for selected length categories.

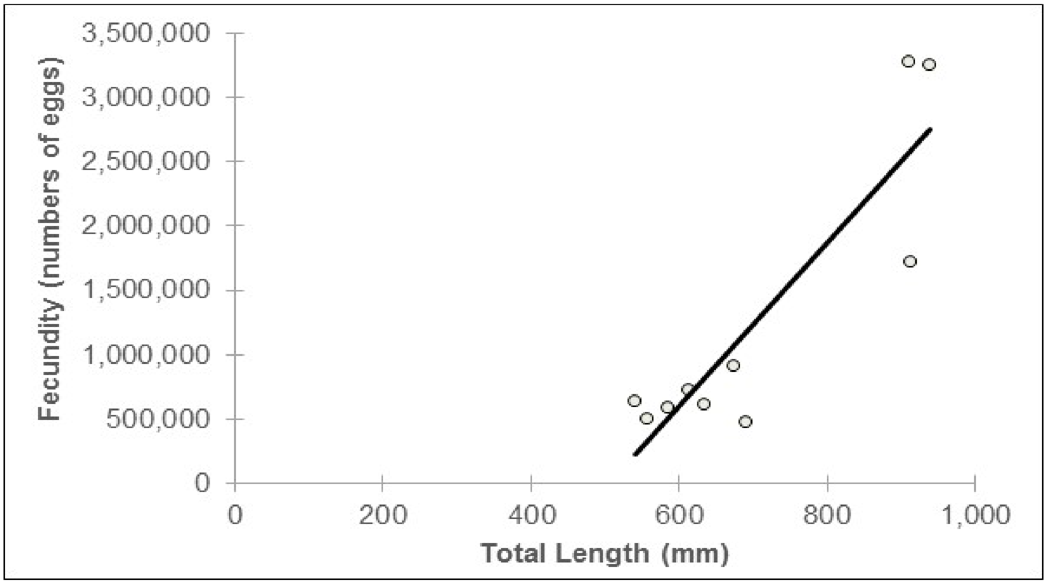

Figure 6.7. Observed (grey circles) and predicted (black line) values of the length-fecundity relationship for non-hatchery origin fish.

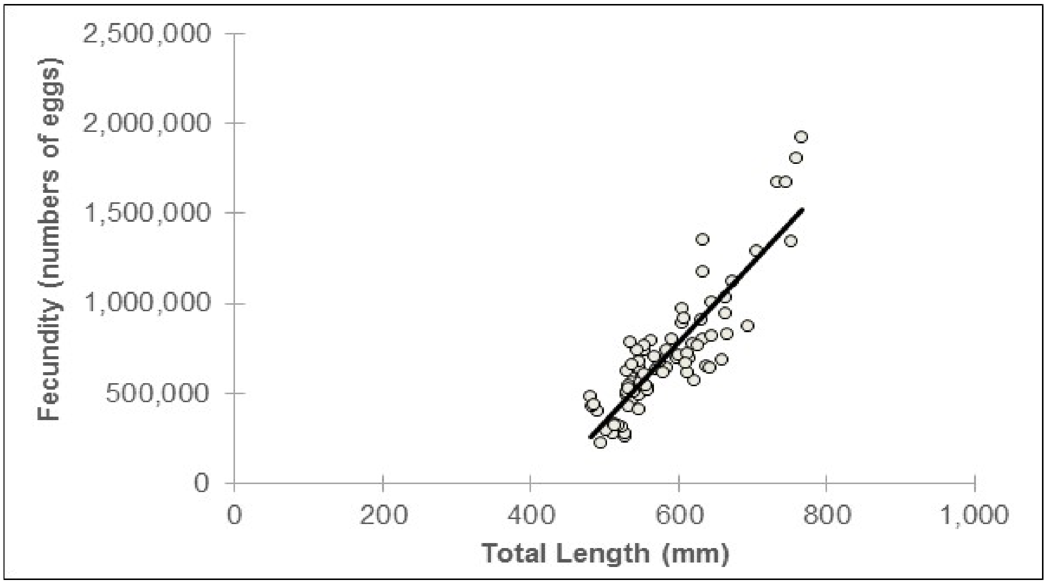

Figure 6.8. Observed (grey circles) and predicted (black line) values of the length-fecundity relationship for hatchery-origin fish.

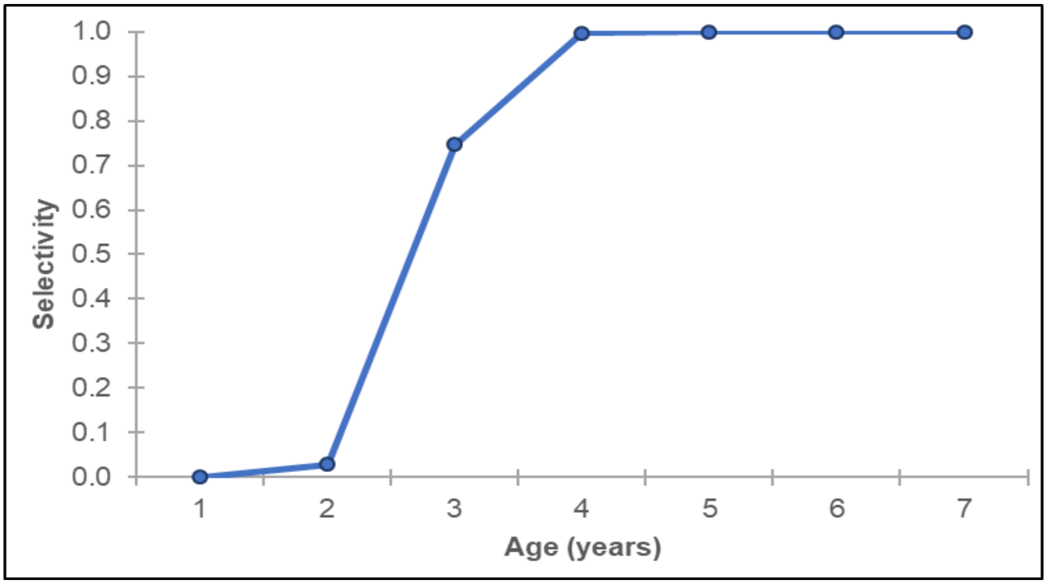

Figure 6.9. Selectivity at age assumed in the per-recruit analyses.

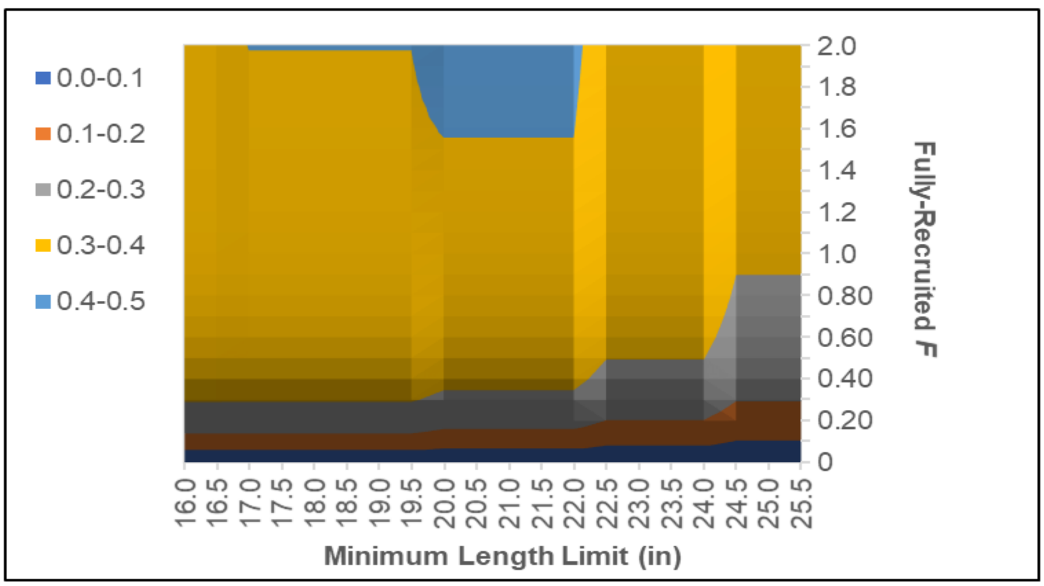

Figure 6.10. Yield per recruit in terms of weight (kilograms) at various combinations of fully-recruited fishing mortality (*F*) and minimum length limits.

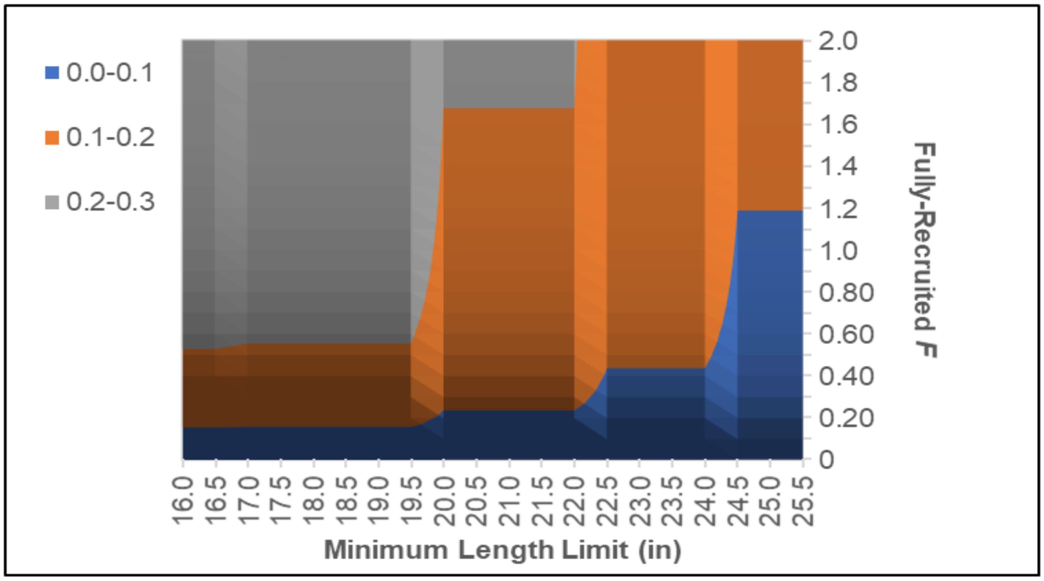

Figure 6.11. Yield per recruit in terms of numbers at various combinations of fully-recruited fishing mortality (*F*) and minimum length limits.

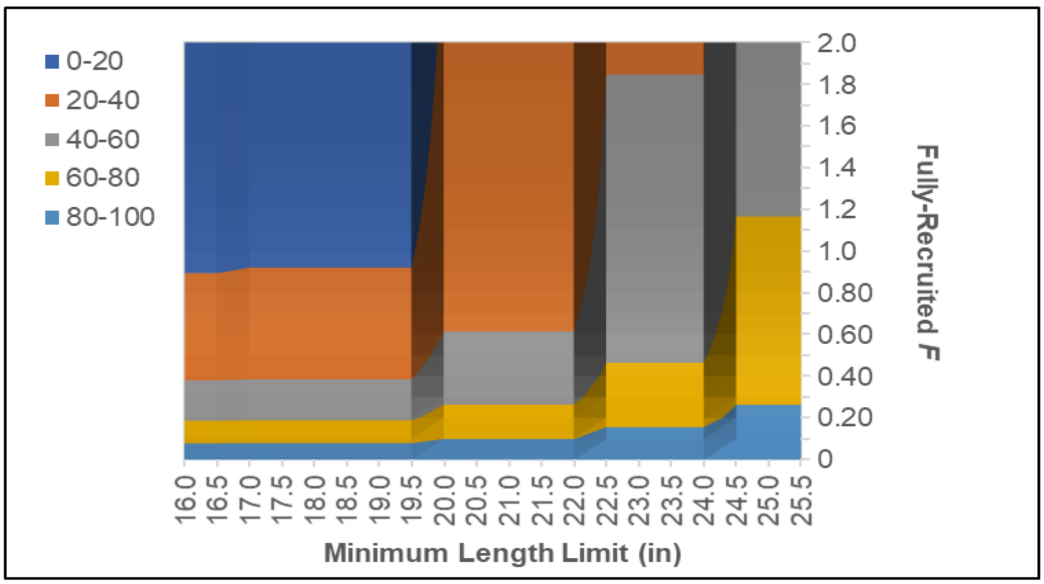

Figure 6.12. Spawning potential ratio (%SPR) at various combinations of fully-recruited fishing mortality (*F*) and minimum length limits.

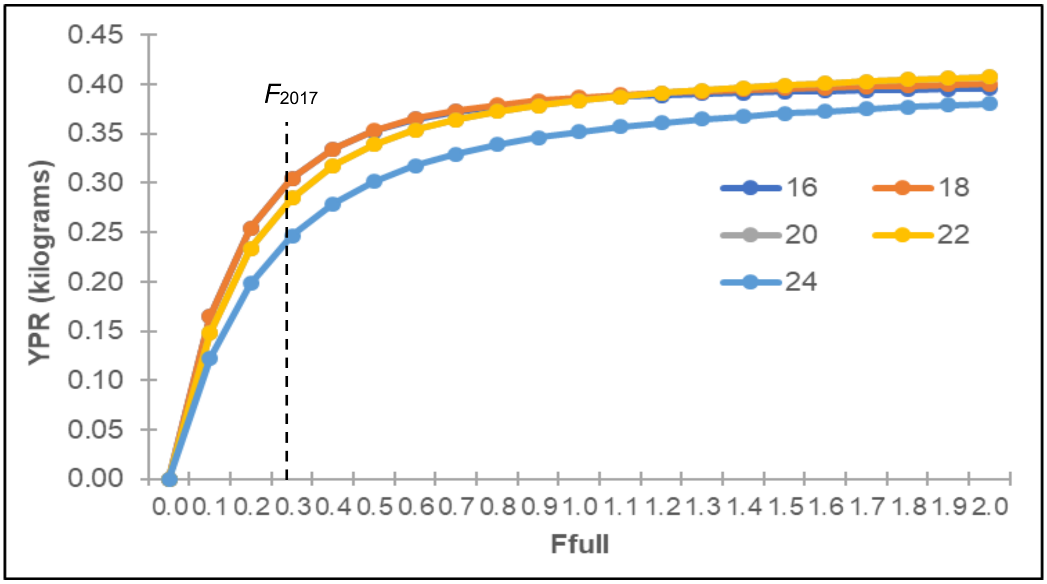

Figure 6.13. Yield per recruit in terms of weight (kilograms) over a range of fully-recruited fishing mortality rates (F_{full}) for select minimum length limits.

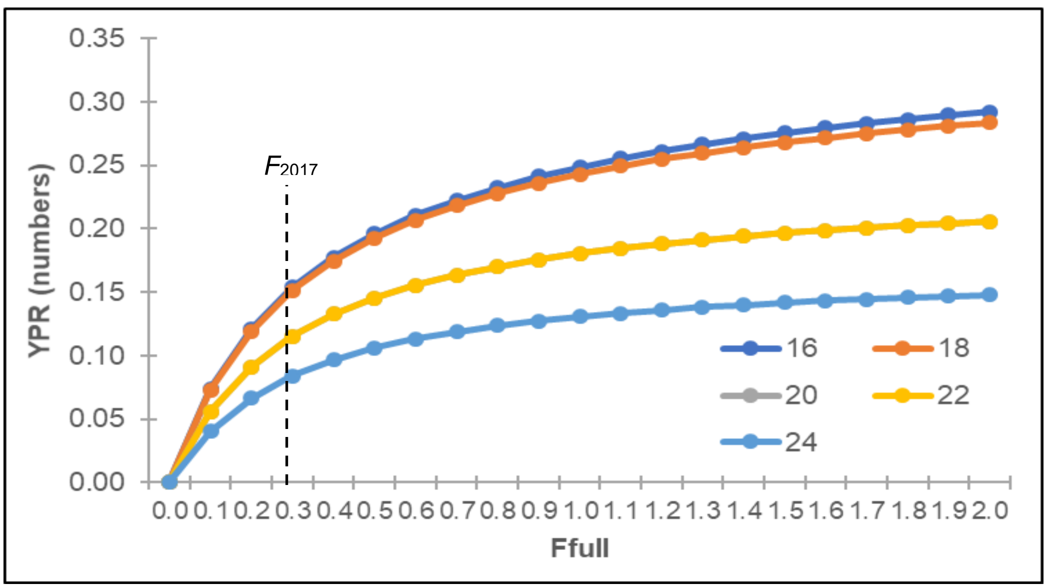

Figure 6.14. Yield per recruit in terms of numbers over a range of fully-recruited fishing mortality rates (F_{full}) for select minimum length limits.

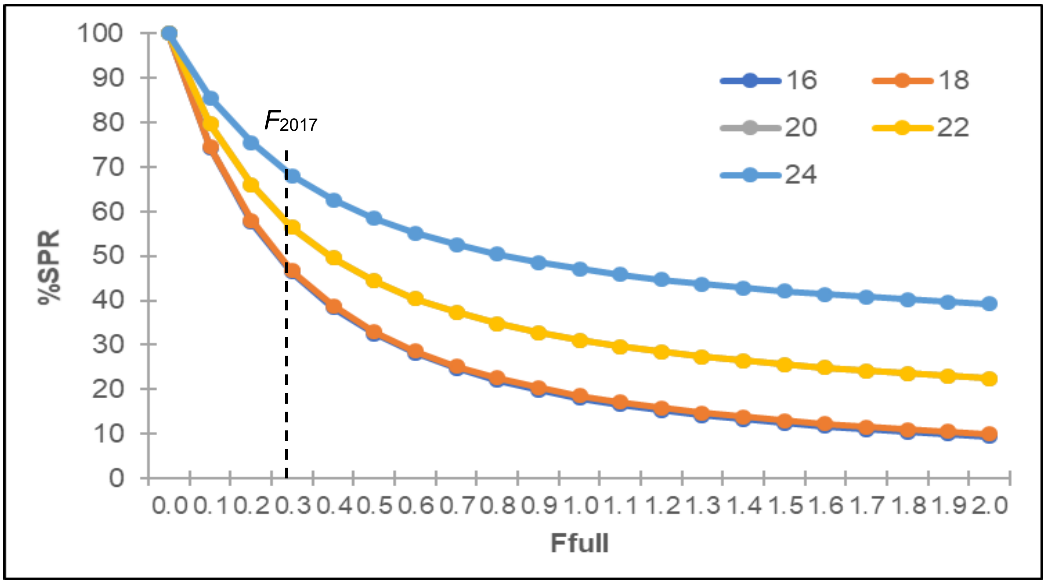

Figure 6.15. Spawning potential ratio (%SPR) over a range of fully-recruited fishing mortality rates (F_{full}) for select minimum length limits.

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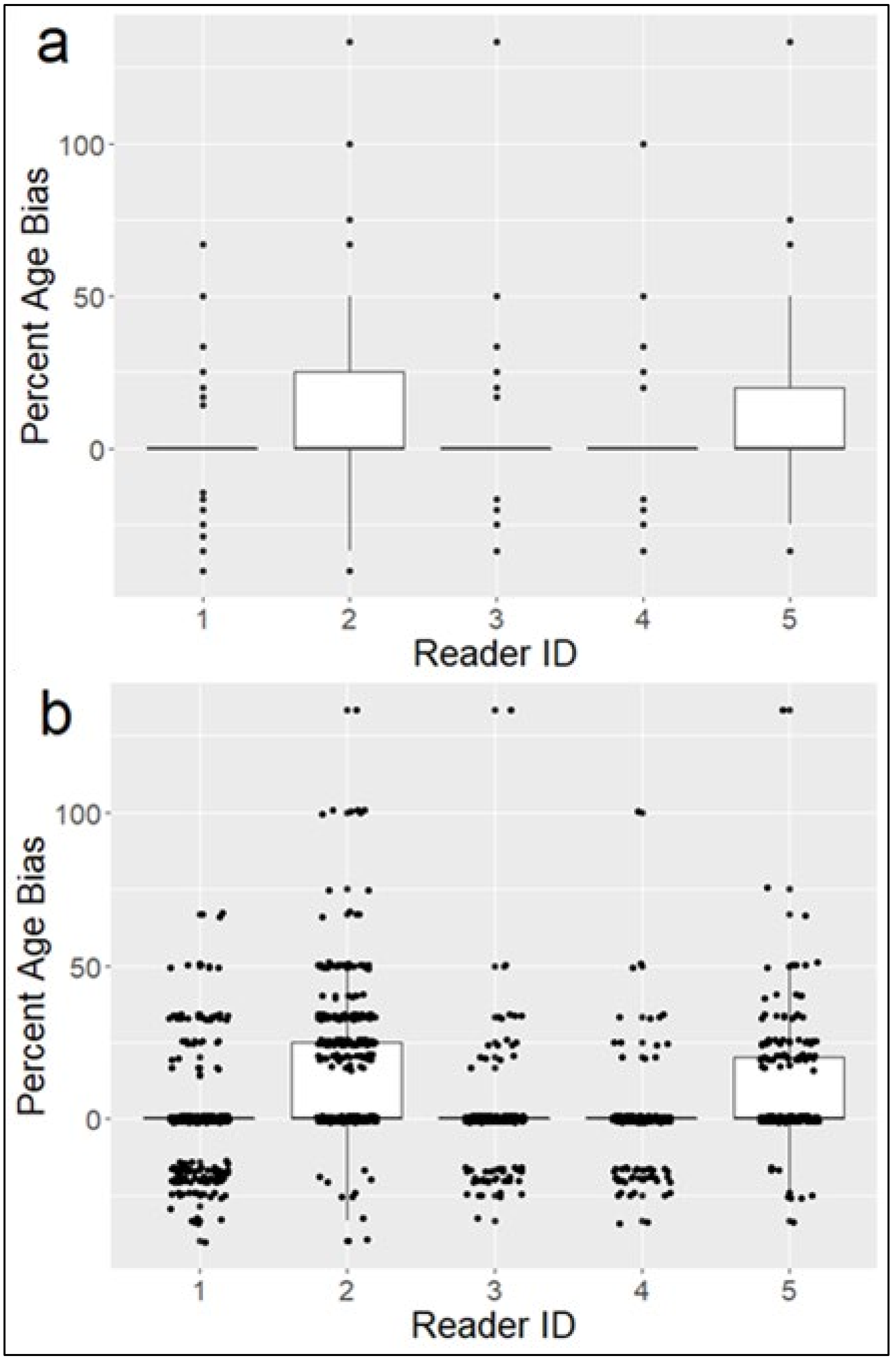

Figure 7.1. Boxplot of percentage age bias by reader ID. The majority of the data points overlapped each other as shown in graph a so the points were jittered (given slightly increased or decreased values) in graph b in order to provide contrasts in data points. The jittered values were not used in the analysis, only to aid in visual inspection of the data.

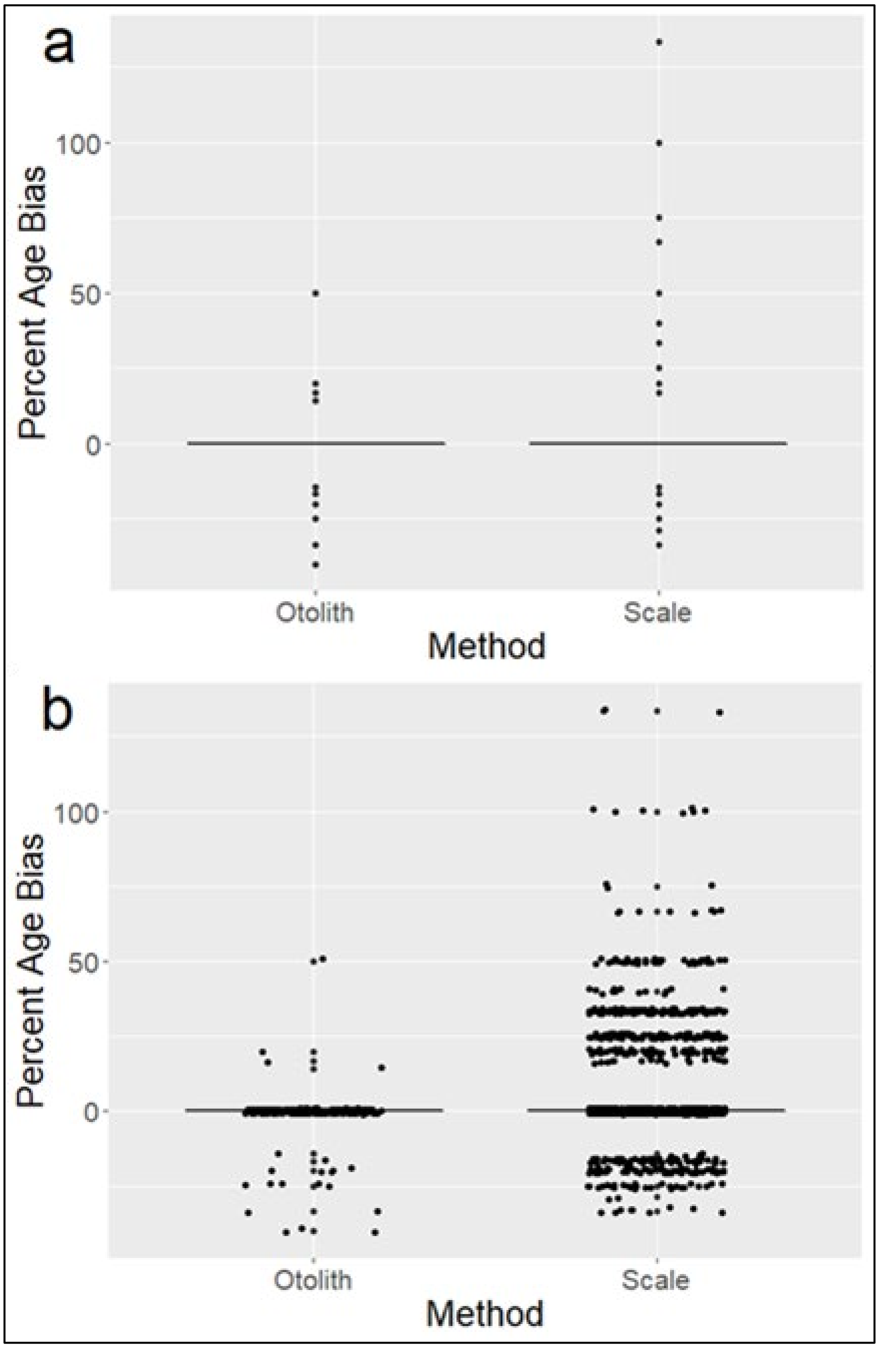

Figure 7.2. Boxplot of percentage age bias by ageing method. The majority of the data points overlapped each other as shown in graph a so the points were jittered (given slightly increased or decreased values) in graph b in order to provide contrasts in data points. The jittered values were not used in the analysis, only to aid in visual inspection of the data.

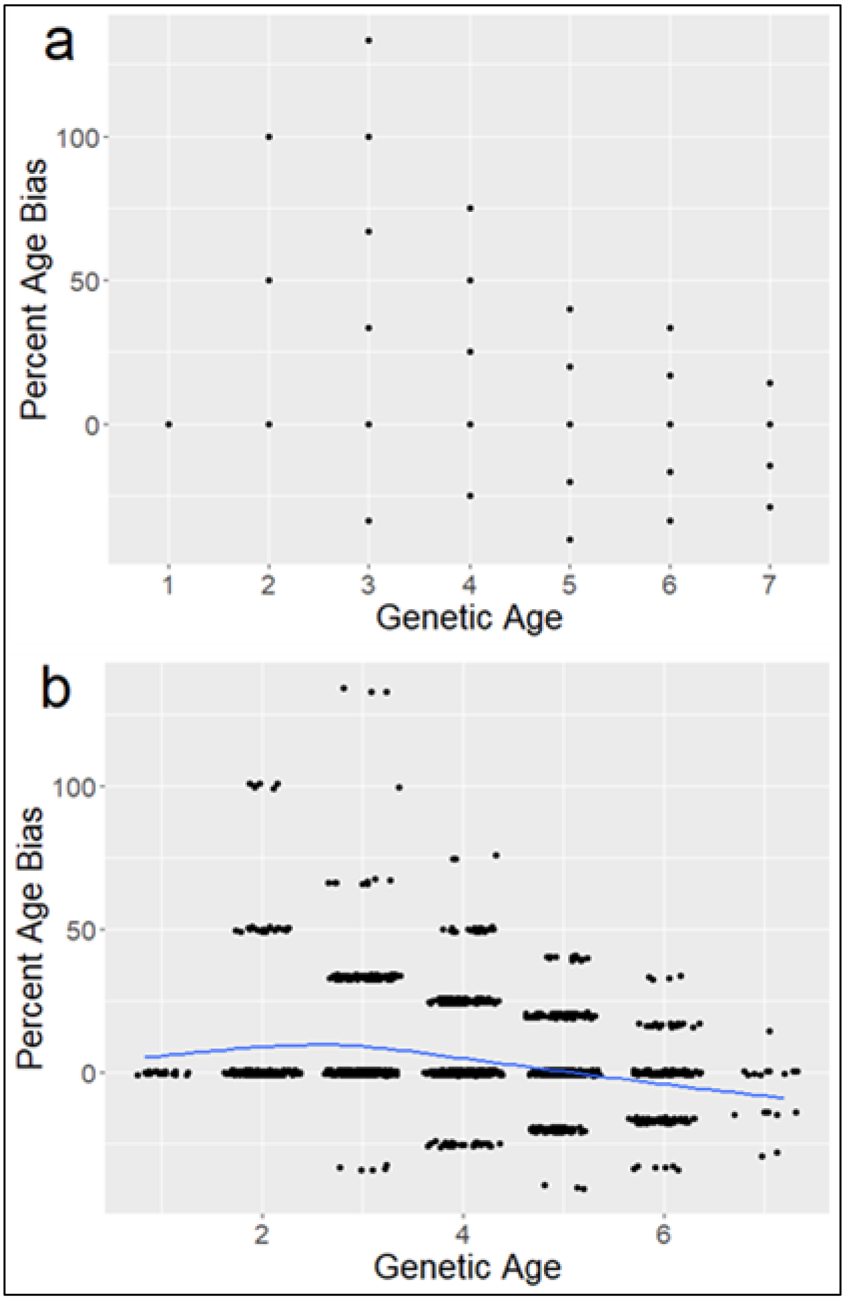

Figure 7.3. Percentage age bias by genetic age (from parental base tagging) with trend line (solid line). The majority of the data points overlapped each other as shown in graph a so the points were jittered (given slightly increased or decreased values) in graph b in order to provide contrasts in data points. The jittered values were not used in the analysis, only to aid in visual inspection of the data.

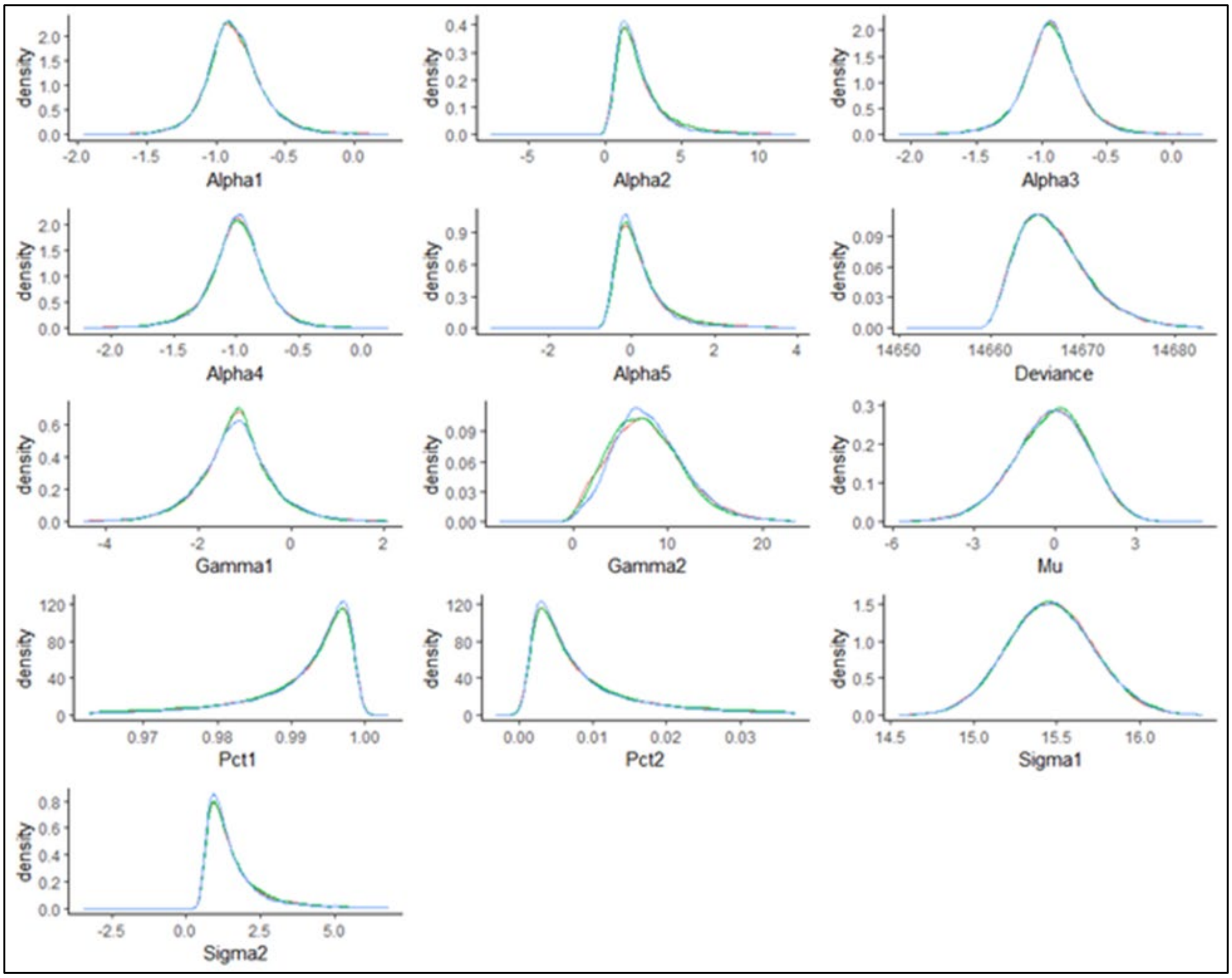

Figure 7.4. Posterior distributions for three chains of parameter estimates from Bayesian generalized linear mixed effects model. Alpha's represent reader effects, gamma's represent method effects, mu represents the overall average bias, pct1 represents percentage of error explained by random error, pct2 represents percentage of error explained by reader effects, sigma1 represents standard deviation associated with random error, sigma2 represents standard deviation associated with reader effects, and deviance is a goodness-of-fit estimate.

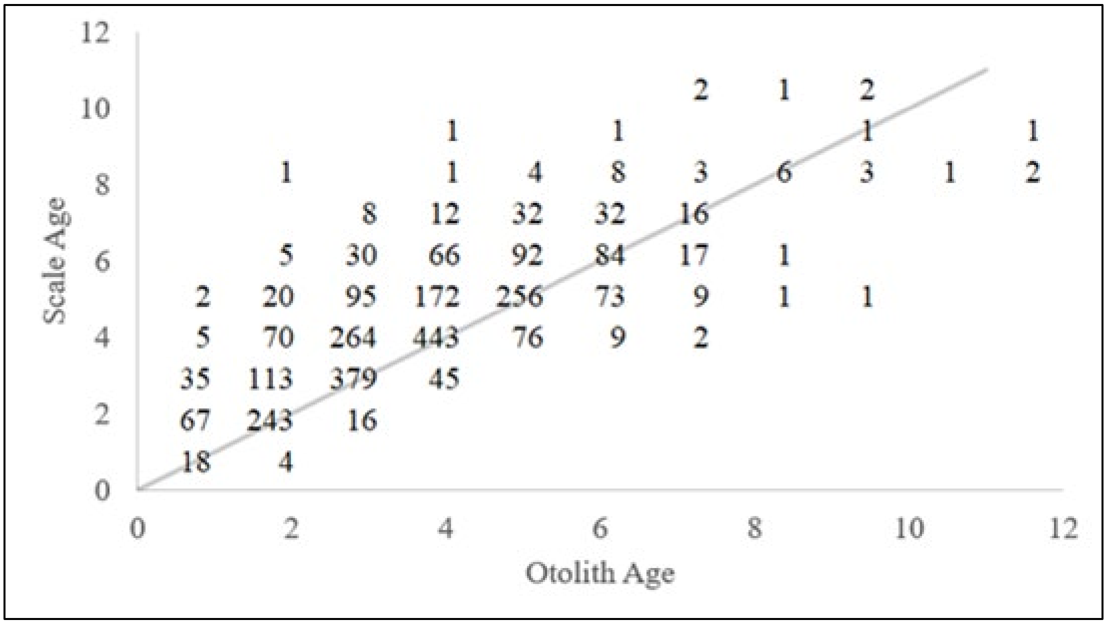

Figure 7.5. Contingency table for number of fish in each scale age for each otolith age. Numbers represent number of fish assigned scale age for a given otolith age.

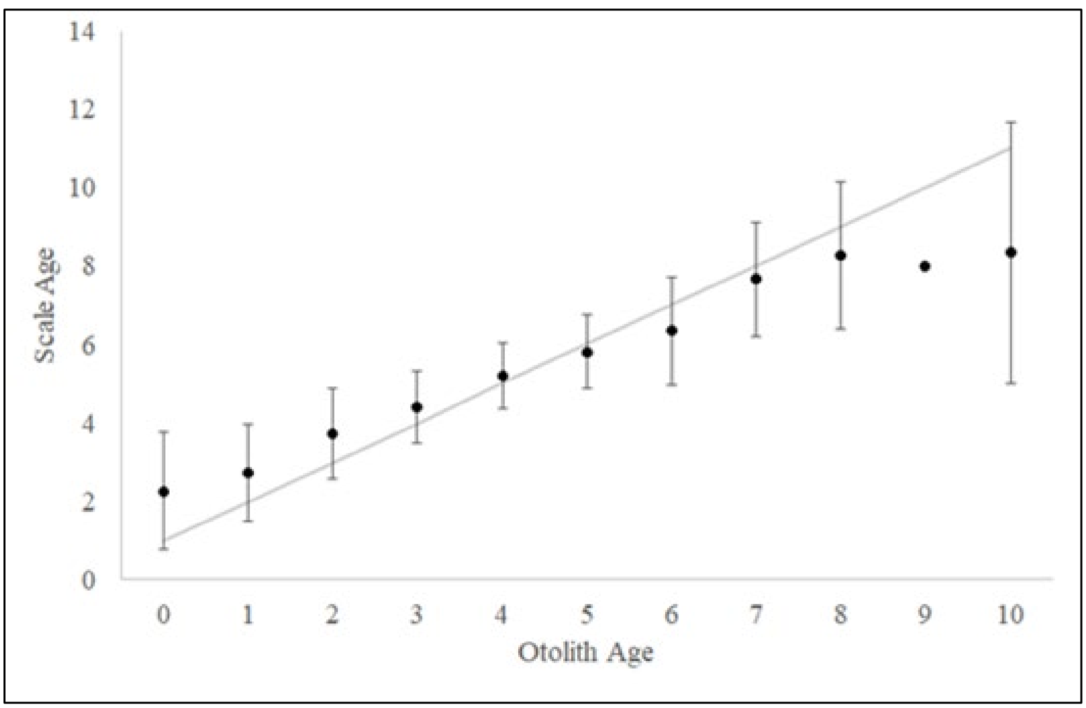

Figure 7.6. Age-bias plot for average scale age for each otolith age with standard deviation.

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FORK LENGTH/ TOTAL LENGTH CONVERSION WORKING PAPER

ESTUARINE STRIPED BASS DATA WORKSHOP
Planning Workshop
March 20, 2017

NC DIVISION OF MARINE FISHERIES
PROGRAM 135 STRIPED BASS INDEPENDENT GILLNET SURVEY (ASMA)
PROGRAM 311 CAPE FEAR RIVER STRIPED BASS MARK RECAPTURE STUDY (CSMA – CAPE FEAR)
PROGRAM 366 MULTI-SPECIES TAGGING PROGRAM (CSMA – CAPE FEAR)
PROGRAM 930 COMPREHENSIVE LIFE HISTORY (CSMA – TAR-PAMLICO, NEUSE, AND CAPE FEAR)

Prepared by: Todd Mathes, Marine Fisheries Biologist I, Washington, NC

Analysis Overview

Differences in striped bass length measurement types collected between and within North Carolina State agencies necessitates standardization to compare samples among systems. The 2017 estuarine striped bass stock assessment planning workshop terms of reference established total length as the standard unit of measurement for the striped bass stock assessment. To this end, simple linear regression was used to compare total length as a function of fork length to establish a conversion for instances where only fork length was recorded.

Data were provided from the divisions' biological database from various fishery independent and dependent data collection programs (Table 1). Geographic areas analyzed included: Albemarle Sound Management Area (ASMA), Central Southern Management Area (CSMA; Pamlico Sound and Tar/Pamlico, Pungo, and Neuse rivers), and CSMA (Cape Fear River).

Program Objectives

The Striped Bass Independent Gillnet Survey (P135) is used to monitor the Albemarle/Roanoke striped bass population. The principle objectives are to describe the striped bass population as to length, age, sex, and relative abundance.

The Cape Fear River Striped Bass Mark Recapture Study (P311) is a tagging study used to: 1) estimate the population size of striped bass in the Cape Fear River, 2) estimate tag loss of internal anchor tags, and 3) compare recapture rates of striped bass caught with hook and line, electrofishing, and gill net gears. Secondary objectives of the study are obtaining age samples from striped bass in the Cape Fear River and determine residency patterns of striped bass in the Cape Fear River.

The Multi-Species Tagging Program (P366) was developed to standardize protocols for coding tag data amongst various existing programs conducted by the division and designed to accommodate future tagging projects as needed regardless of species being tagged. The overall objective is to provide a multi-species tagging program with a standardized coding procedure for conventional

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tags. The specific objectives are to: 1) estimate tag-retention rates, tag-reporting rates, fishing mortality by fishing sector, and migration rates for red drum, striped bass, spotted seatrout, southern flounder, and cobia 2) estimate fishing mortality by fate (harvest or release), age, and fishing sector and to provide selectivity estimates by fate, age and fishing sector for red drum, striped bass, spotted seatrout, southern flounder, and cobia, and 3) assess annual variation in fishing and natural mortalities using a tag-return model, conventional catch-at-age stock assessment model, or an integrated tag-return catch-at-age model for red drum, striped bass, spotted seatrout, southern flounder, and cobia.

The Comprehensive Life History Program (P930), created in 1985, was developed to increase the understanding of the population dynamics and life history of North Carolina fishes and to collect fish ageing structures and other biological data to develop and validate life history information.

Survey Design & Methods

Data Source

The Striped Bass Independent Gillnet Survey (P135), ongoing since October 1990, is a random stratified multi-mesh monofilament gillnet survey. Mesh sizes used in the survey consist of 2.5 through 7.0 inch stretched mesh (ISM) at ½ inch increments, and 8.0 and 10.0 ISM. The fishing year is divided into three segments: (1) a fall/winter survey period, which begins approximately 1 November and continues through 28 February, (2) a spring survey period which begins 1 March and continues through approximately 30 June, and (3) a summer survey period which starts 1 July and continues through 30 October.

The Cape Fear River Striped Bass Mark Recapture Study (P311), 2010-2014, sampled thirty-two fixed stations in addition to randomly selected stations that were sampled in January to April each year. In 2015 striped bass tagging from this program transitioned to P366 and its sampling protocols.

The Multi-Species Tagging Program (P366), implemented 1 October, 2014, is the primary program for documenting the divisions' conventional fish tagging. Red drum, striped bass, spotted seatrout, sturgeon, southern flounder, and cobia are tagged by division staff using a variety of methods. Fish are captured through division fishery independent and dependent sampling programs. A limited number of recreational hook-and-line fishermen recruited by division staff will also tag these fish species. Sampling for this program is diverse both geographically and by gear type to achieve the studies objectives.

The Comprehensive Life History Program (P930) began collecting and ageing of fish otoliths and scales in the late 1970's. Currently, regular data collection occurs for approximately 20 recreationally and commercially important North Carolina finfish species. In the past, P930 has had no specific sampling design; ageing samples have been collected opportunistically or as needed from division fishery independent sampling, commercial catches, and recreational catches, depending on the species. Otoliths and/or scales are collected monthly from American shad, Atlantic croaker, Atlantic menhaden, black drum, black sea bass, bluefish, cobia, kingfishes, mackerels, flounders, red drum, sheepshead, spotted seatrout, spot, striped bass, striped mullet, and weakfish.

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Analysis Methods

Due to the large number of observations within the ASMA data set, spanning 1990 to present, only years 2000-2016 were used for the analysis. Initial data provided were screened to remove outliers. Two methodologies were used to establish a threshold to identify outliers: (1) ***(TL-FL)/TL>15%***, and (2) ***FL>TL***. Once the outliers were identified/removed, data were further cleaned to ensure accuracy of coding. Simple linear regression was then used to compare total length as a function of fork length. Simple linear regression is a parametric statistical test predicated on assumptions of normality, and homoscedasticity (equality of variances). Linear regression tests the null hypothesis that there would be no significant prediction of total length by fork length. All data were analyzed using SAS 9.3.

Our hypotheses are as follows:

H_0: ρ=0 there is no correlation between fork length and total length within our population

H_0: ρ≠0 there is a significant correlation between fork length and total length

Where ρ is our correlation coefficient (measures the strength and direction of a linear relationship between two variables)

A student's t-test is used to determine if the relationship between our independent (fork length) and dependent variables (total length) are different from zero.

$t = r\sqrt{(n\text{-}2)/(1\text{-}r^2)}$

where, $r = 1/n\text{-}1\sum(x_i\text{- } x)(y_i\text{-}y)/s_x s_y$

Results

Results of the analyses validates that the assumptions of normality had been met (Figure 1, Figure 3, and Figure 5), and that the amount of variability within datasets were very low (Figure 2, Figure 4, and Figure 6) demonstrating equality of variances.

Conclusion

Regressions from all three areas exhibited essentially the same slopes and Y intercepts differed by less than 5 millimeters. Based on these results, it is appropriate to pool data from all the regions. In conclusion, when converting fork length to total length, pooled data can be used to accurately predict total length. Listed below are the formulas for converting fork length to total length, as well as a reciprocal equation in case there is an instance where total length needs to be converted to fork length.

FL to TL Conversion Formula:
Total Length = 6.206909513 + (1.055954699 * Fork Length)

Example:
FL = 640 mm, what's the TL?
TL = 6.206909513 + (1.055954699 * 640) =
TL = 6.206909513 + 675.811 =
TL = 682.0179 mm
TL = 682 mm

Reciprocal TL to FL Conversion Formula:
Fork Length = (Total Length * 0.945673822) – 5.277089838

Example:
TL = 682 mm, what's the FL?
TL = (682 * 0.945673822) – 5.277089838 =
TL = 644.949546604 – 5.277089838 =
TL = 639.6724 mm
TL = 640 mm

Dataset Information

Charlton Godwin, Charlton.Godwin@ncdenr.gov,
File Location:
U:\striped bass\Stock Assessment Benchmark FMP 2017\2_Data Workshop\Data\Life History\FL-TL Conversion
P135 dataset:
AR STB FL TL conversion.xlsx

Chris Stewart, Chris.Stewart@ncdenr.gov
File Location:
U:\striped bass\Stock Assessment Benchmark FMP 2017\2_Data Workshop\Data\Life History\FL-TL Conversion
P311, P366, and P930 dataset:
p311&366_cfr_stb.sas7bdat
cfr_stb.sas7bdat

Chris Wilson, Chris.Wilson@ncdenr.gov
File Location:
U:\striped bass\Stock Assessment Benchmark FMP 2017\2_Data Workshop\Data\Life History\FL-TL Conversion
SAS Program:
length regression.sas
Analysis dataset:
sbass.sas7bdat
eg_clean.sas7bdat

Todd Mathes, Todd.Mathes@ncdenr.gov
File Location:
U:\striped bass\Stock Assessment Benchmark FMP 2017\2_Data Workshop\Data\Life History\FL-TL Conversion
P930 dataset:
CSMA STB FL to TL conversion (4-20-17).xls

Tables

Table 1. FL to TL conversion data description.

Area	Program	n	Years	Data Source
ASMA	P135	40,073	2000–2016	Charlton Godwin
CSMA—Tar-Pamlico	P930	3,764	2000–2016	Todd Mathes
CSMA—Neuse	P930	2,482	2000–2016	Todd Mathes
CSMA—Cape Fear	P311, P366, P930	2,372	2011–2016	Chris Stewart

Figures

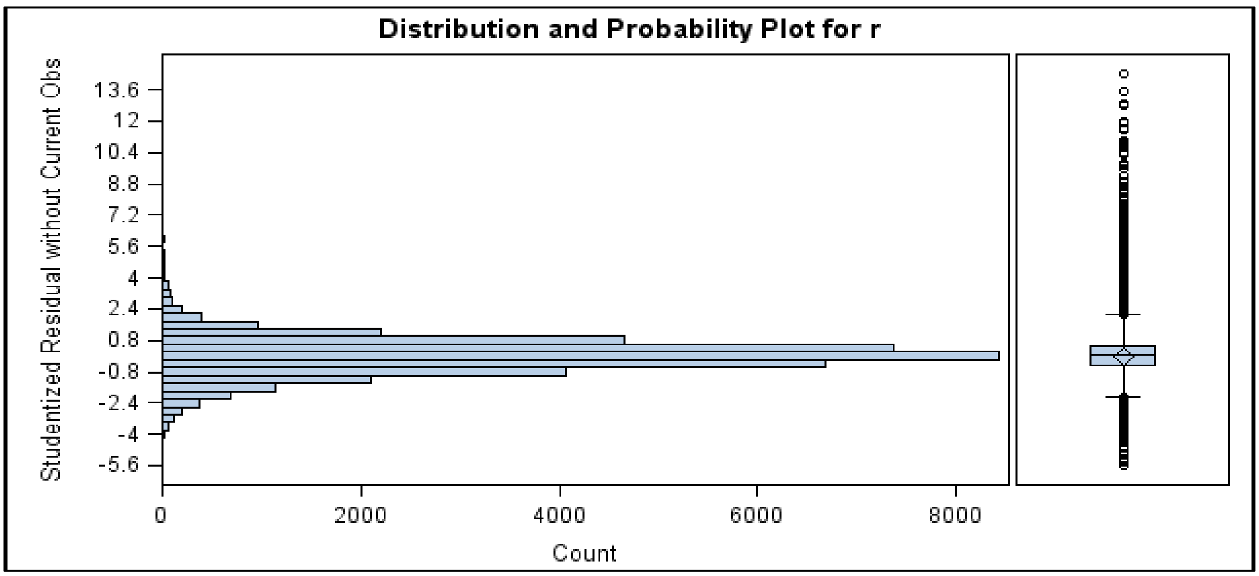

Figure 1. ASMA residual plot validating assumptions of normality.

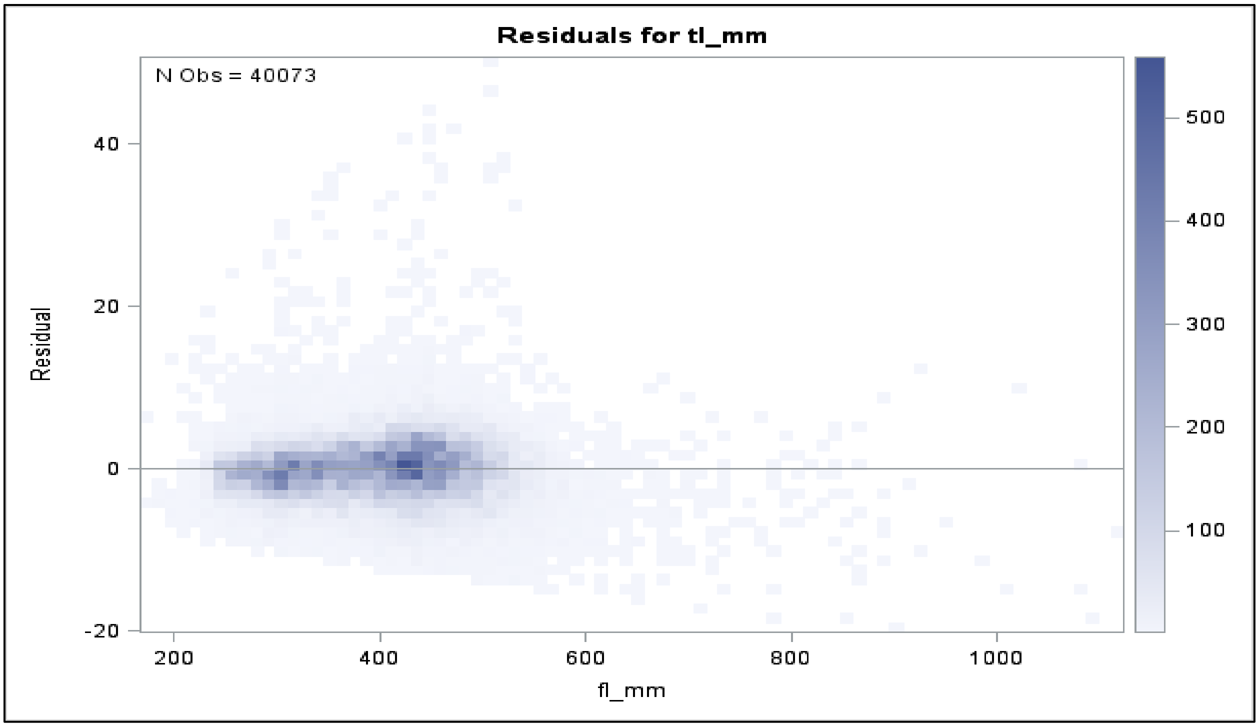

Figure 2. ASMA residuals demonstrate low variability associated with the best fit line.

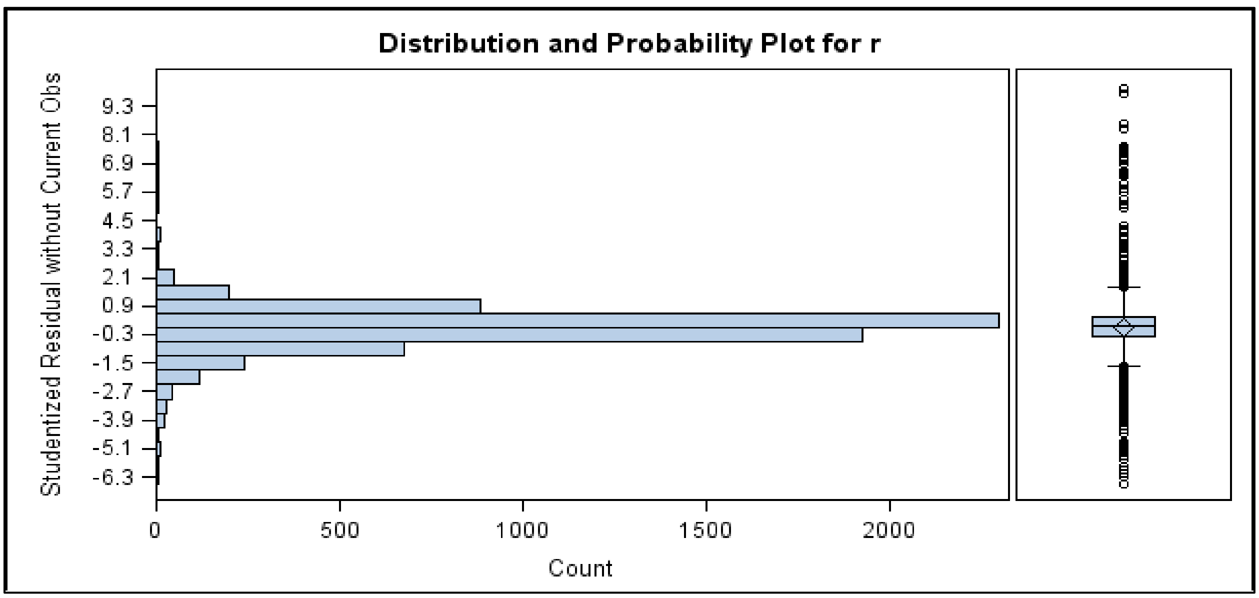

Figure 3. CSMA residual plot validating assumptions of normality.

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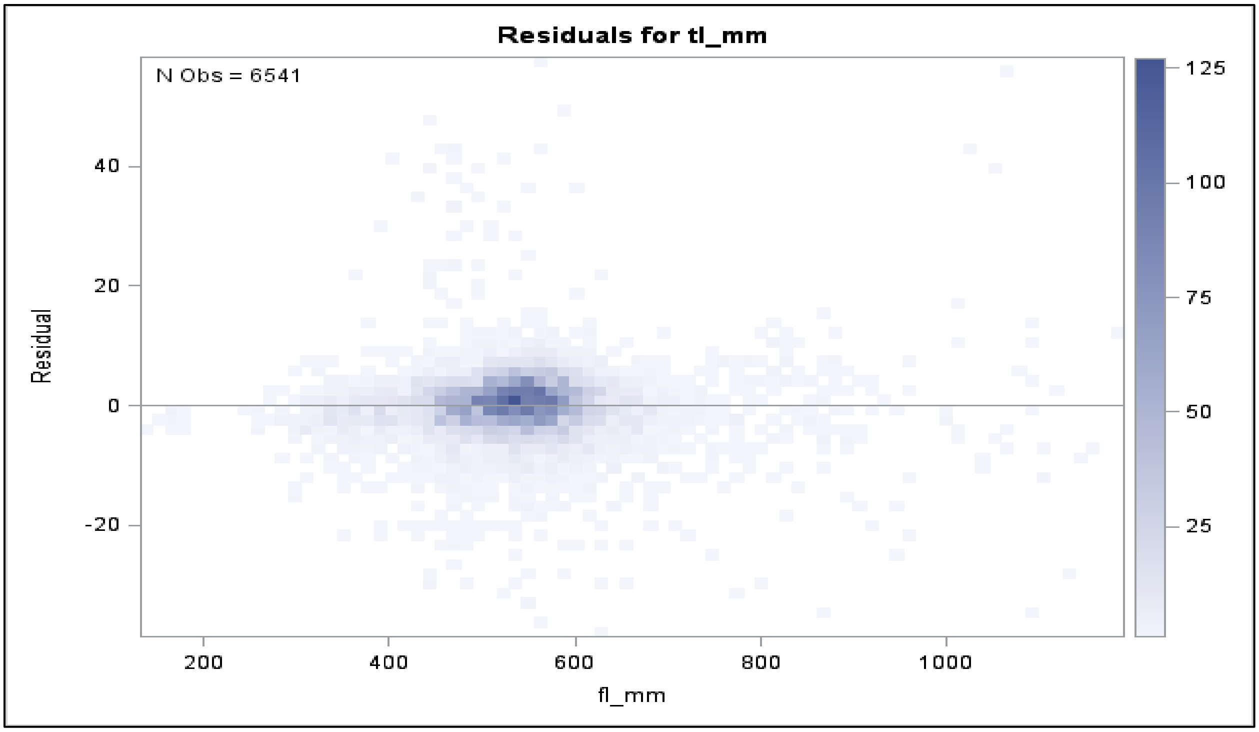

Figure 4. CSMA residuals demonstrate low variability associated with the best fit line.

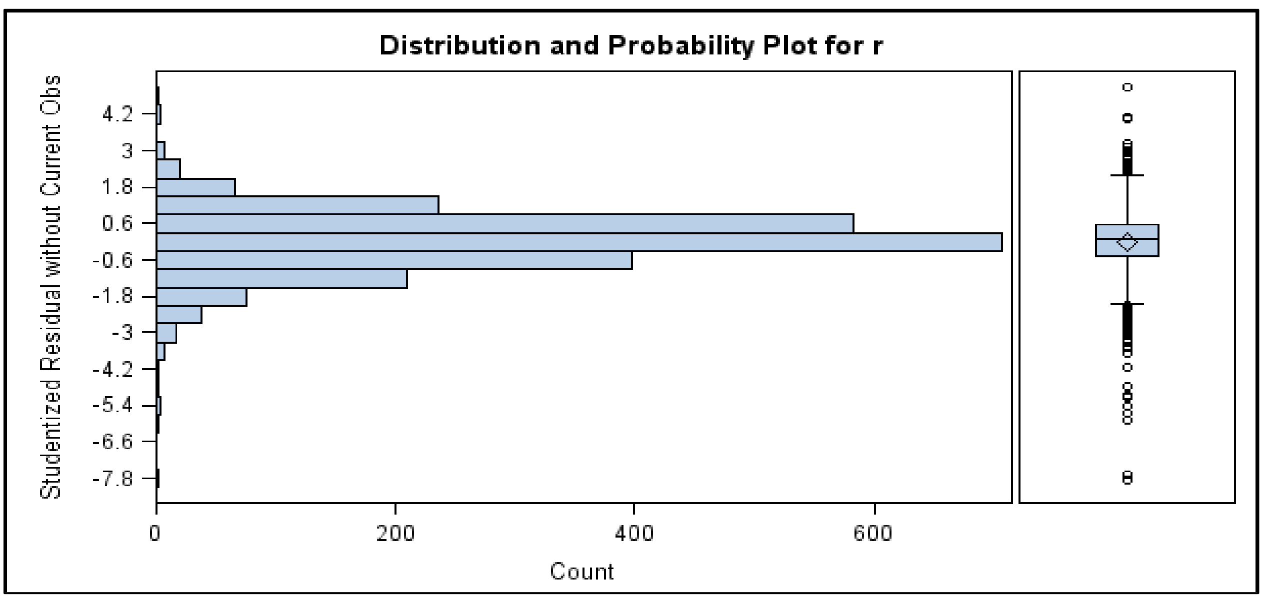

Figure 5. Cape Fear residual plot validating assumptions of normality.

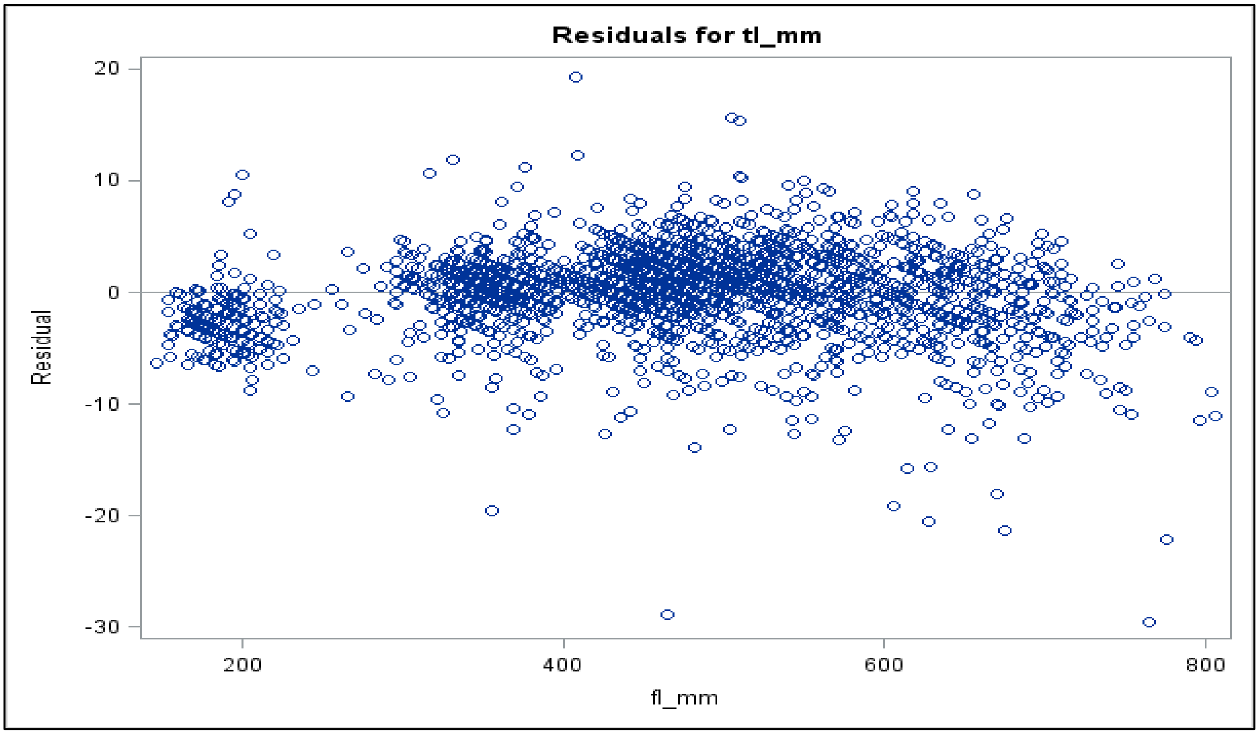

Figure 6. Cape Fear residuals demonstrate low variability associated with the best fit line (number of observations=2,372).

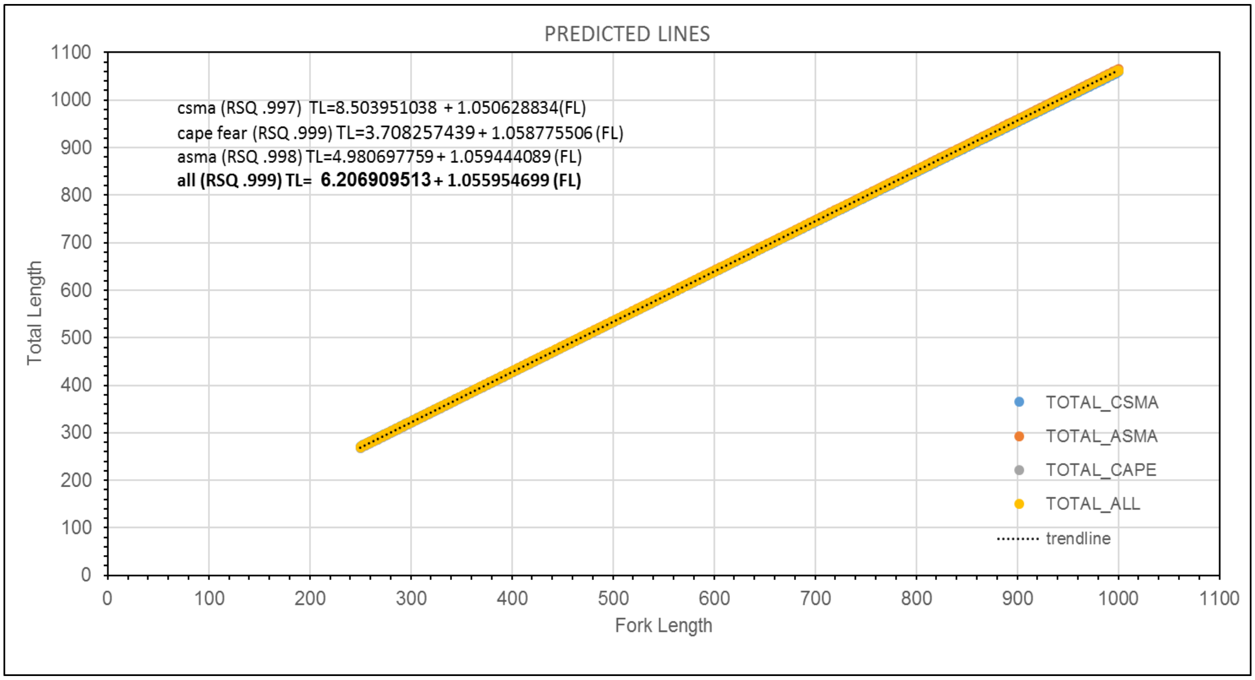

Figure 7. Regression analyses show strong relationships for CSMA, Cape Fear, ASMA, and all areas combined. The high RSQ value indicates a strong fit.

13 APPENDIX B

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ARTICLE

Exploring Causal Factors of Spawning Stock Mortality in a Riverine Striped Bass Population

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Abstract

The recovery of the Atlantic Striped Bass *Morone saxatilis* stock in the 1990s is an important example of effective natural resources management. Implementation of Atlantic States Marine Fisheries Commission (ASMFC) harvest regulations reduced mortality, protected older and more fecund females, and contributed to the formation of dominant year-classes in the 1980s and 1990s. However, Striped Bass stocks south of Albemarle Sound, North Carolina, are not subject to ASMFC management plans, and many populations have failed to attain recovery goals. Catch-curve analyses indicate that the Neuse River Striped Bass population continues to experience spawning stock exploitation rates similar to those implicated in the decline of the Atlantic Migratory and Albemarle Sound/Roanoke River stocks in the 1970s. From 1994 to 2015, Striped Bass instantaneous fishing mortality (F) in the Neuse River ranged from 0.12 to 0.84 and exceeded the overfishing threshold ($F_{Threshold}$ = 0.41) in 12 of 22 years. A global linear model using environmental and exploitation factors accounted for 55% of the variability in spawning stock discrete annual mortality. An information-theoretic approach was used to elucidate the best linear model for predicting discrete annual mortality. The best model included previous-year gill-net effort and same-year commercial harvest (Akaike weight = 0.64, R^2 = 0.50). Model-averaged coefficients for gill-net effort and commercial harvest suggested total exploitation impacts that were congruent with other studies of Neuse River Striped Bass. Results indicate that reducing exploitation to target levels will require substantial reductions in gill-net effort in areas of the Neuse River where Striped Bass occur. Reducing exploitation may increase spawning stock biomass and advance the age structure of spawning females, conferring an increased likelihood of successful recruitment and production of dominant year-classes during periods of favorable environmental conditions.

Striped Bass *Morone saxatilis* populations sustained severe declines in abundance throughout the U.S. Atlantic coast in the 1970s after several years of record commercial harvest combined with poor recruitment (Boreman and Austin 1985; Richards and Deuel 1987). In North Carolina, Striped Bass commercial landings declined by 80% between 1973 and 1983 (Boreman and Austin 1985). Recovery efforts began with the development of the Atlantic States Marine Fisheries Commission's (ASMFC) Interstate Fisheries Management Plan for Striped Bass (IFMP) in 1981 (Richards and Rago 1999). A centerpiece of the IFMP and its amendments was the use of harvest restrictions to curtail overexploitation. The harvest provisions of the IFMP were implemented in North Carolina beginning in 1984, along with an expansion of Striped Bass stocking programs and continued development of optimized streamflow releases from Roanoke Rapids Dam to improve spawning conditions in the Roanoke River, North Carolina (Figure 1; NCDENR 2004, 2013). Albemarle Sound/Roanoke River

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Striped Bass were declared recovered in 1997 (NCDENR 2004).

In North Carolina, Striped Bass populations south of Albemarle Sound (Figure 1) are not subject to compliance with ASMFC management plans due to their minimal contribution to the Atlantic Migratory stock (Merriman 1941; Greene et al. 2009). These populations are collectively managed as the Central Southern Management Area (CSMA) stock under a collaborative agreement by the North Carolina Division of Marine Fisheries (NCDMF; coastal waters) and the North Carolina Wildlife Resources Commission (NCWRC; inland waters). Of the populations comprising the CSMA, Neuse River Striped Bass were among the first to receive targeted monitoring and management actions (Hammers et al. 1995).

Although Striped Bass are documented as historically utilizing all major coastal North Carolina rivers (Smith 1907), the Neuse River population was among the most studied by early ichthyologists. In the 19th century, the population was subject to the second-largest Striped Bass fishery in North Carolina after the fisheries operating on the Albemarle Sound/Roanoke River stock. Yarrow (1877) described Striped Bass in the Neuse River as "exceedingly plenty" and reported that 3,000 were sold to New Bern (Figure 1) fish houses from January to April 1873 (Yarrow 1874). By 1880, almost 16,000 Striped Bass were harvested and shipped from New Bern to northern cities, with an additional unknown quantity consumed locally during the fishing season (McDonald 1884). Despite their former abundance, declines were evident before the end of the 19th century, leading McDonald (1884) to note that "…the supply has materially decreased…owing to overfishing and the erection of obstructions." By 1939, only 318 kg of Striped Bass were commercially harvested in Craven County (Figure 1; Chestnut and Davis 1975).

Although fishing records during World War II are sparse, acquisition of fishing vessels and labor for the war effort likely reduced Striped Bass harvest and allowed for stock rebuilding. Fishing restrictions and labor shortages were eased toward the end of the war, leading to the harvest of 18,000 kg of Striped Bass in Craven County during 1945 (Anderson and Power 1949). However, construction of Quaker Neck Dam in 1952 prohibited access to essentially all spawning habitat (Burdick and Hightower 2006). By the mid-1960s, recreational and commercial anglers reported population declines, and a subsequent 3-year NCWRC survey collected only 12 adult fish (Miller 1975). Despite minimal harvest restrictions, commercial landings remained low throughout the latter half of the 20th century and did not exceed 4,500 kg again until 2010 (NCDMF, unpublished data). It is possible that the intensity of post-war fishing in the lower Neuse River

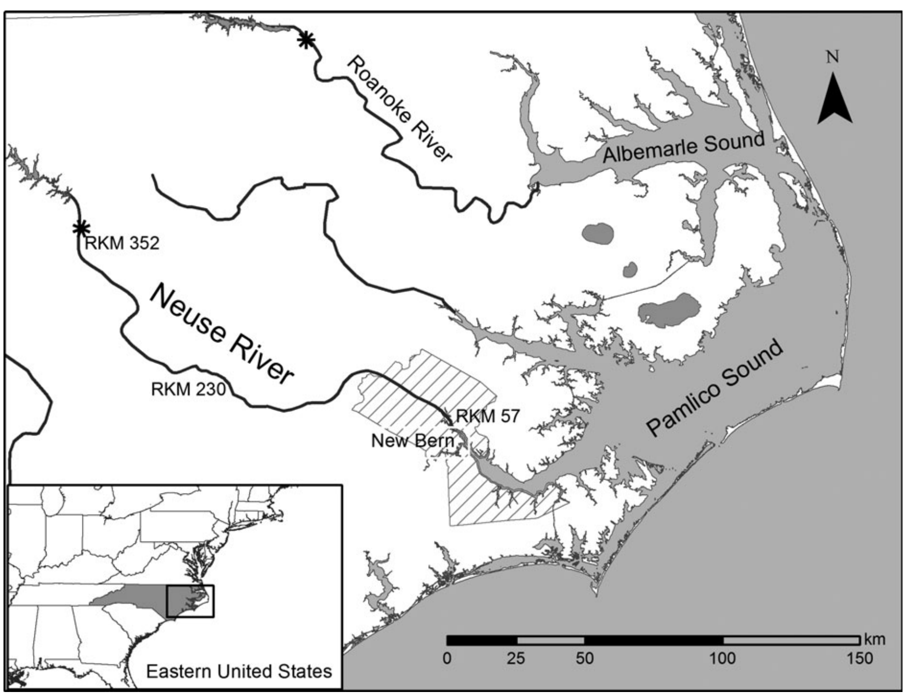

FIGURE 1. Coastal North Carolina, showing the Neuse River in relation to Pamlico Sound; RKM denotes river kilometers from the confluence of the Neuse River and Pamlico Sound. The first impediments to upstream migration (Milburnie Dam on the Neuse River; Roanoke Rapids Dam on the Roanoke River) are indicated by black asterisks. Gray diagonal lines denote Craven County.

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combined with an inability to access suitable spawning habitat led to the near extirpation of the population.

Active management efforts in the Neuse River began with the implementation of an annual stocking regime in 1992 (although intermittent stocking began as early as 1931). In 1994, annual spawning ground surveys commenced, and a 11,340-kg commercial harvest quota was established for the entire CSMA stock (NCDENR 2004). The removal of Quaker Neck Dam in 1998 allowed unobstructed access to approximately 120 km of historical spawning habitat (Burdick and Hightower 2006). Finally, gill-net use was prohibited in NCWRC-managed inland waters in 2001 (NCDENR 2013).

Recovery efforts were first formalized in 2004 as part of the North Carolina Estuarine Striped Bass Management Plan (NCDENR 2004) that was jointly developed by NCDMF and NCWRC. Unweighted linearized catch-curve analyses of age structures collected on the Neuse River spawning grounds indicated that overfishing was occurring (NCDENR 2004), leading to the implementation of gill-net restrictions in 2008 (established minimum distance from shore and use of tie-downs during the closed harvest season; NCDENR 2013). A stock assessment conducted in 2010 using unweighted linearized catch curves again documented high mortality, but the assessment was deemed unsuitable for management use due to large confidence intervals around the mortality estimate. However, the need for continued conservation management measures was supported by truncated size and age distributions, low CPUE, and an absence of older fish in spawning ground samples. Albemarle Sound/Roanoke River spawning potential ratios of 45% and 40% were used to develop biological reference points for the Neuse River, resulting in an instantaneous fishing mortality rate (F) target (F_{Target}) of 0.33 and an overfishing threshold ($F_{Threshold}$) of 0.41 (NCDENR 2013, 2014).

Electrofishing assessments on the spawning grounds indicate that size and age distributions have not expanded since the 2010 stock assessment (Rachels and Ricks 2015). Additionally, recent results utilizing parentage-based tagging (PBT) indicate that hatchery fish (Table 1) comprise at least two-thirds of the spawning stock (O'Donnell et al. 2016) and may approach 100% stocking contribution (Rachels and Ricks 2015; O'Donnell et al. 2016). The development of recommendations for catch-curve best practices (Smith et al. 2012) render former Neuse River Striped Bass stock assessments obsolete and present an opportunity to re-evaluate spawning ground age-structure data. Our objectives were two-fold: (1) to improve the precision of catch-curve mortality estimates by using current methodology and an expanded time series; and (2) to use linear modeling in an information-theoretic approach (Burnham and Anderson 2002) to elucidate factors responsible for driving the observed mortality rates.

METHODS

Study area.— The Neuse River flows approximately 400 km from its origin at the confluence of the Eno and Flat rivers before discharging into Pamlico Sound, North Carolina (Figure 1). The lower 60 km constitute a wind-mixed mesohaline estuary, although salinity can range from 0‰ to 27‰ depending on precipitation and streamflow (Burkholder et al. 2006). The Neuse River estuary has been classified as "Nutrient Sensitive Waters" since 1988 (NCDENR 2006) and experienced numerous algae blooms and fish kills during the 1990s resulting from nitrogen and phosphorus inputs (Burkholder et al. 1995, 2006; Rothenberger et al. 2009).

Mortality estimation.— From 1994 to 2015, boat-mounted electrofishing (Smith-Root 7.5 GPP; 120 Hz; 5,000–7,000 W) was used to collect Striped Bass from the spawning grounds during annual spawning migrations (March–May). Collections primarily occurred between river kilometer (RKM) 230 of the Neuse River (measuring from its confluence with Pamlico Sound) and RKM 352. Few Striped Bass were collected above Quaker Neck Dam (RKM 230; Figure 1) before its removal in 1998.

Striped Bass were measured for TL (mm) and weighed (g), and sex was determined by applying pressure to the abdomen and observing the vent for discharge of milt or eggs. Scales for age estimation were removed from the left side of each fish between the dorsal fin and lateral line. From 1994 to 2014, 15 fish of each sex per 25-mm size-class were aged by either directly reading scales (1994–2010) or reading scale impressions on acetate slides (2011–2014). Since sampling occurred during the time of year when annuli are formed, scale age was based on (1) the actual number of annuli if an annulus was present on the scale margin; or (2) the number of annuli plus 1 if there was a considerable gap between the last annulus and the scale margin (NCWRC and NCDMF 2011). A 20% subsample of each size-class was aged by a second reader. Discrepancies between primary and secondary readers' estimates were resolved by jointly reading and reaching consensus (NCWRC and NCDMF 2011). In 2015, a partial pelvic fin clip from each fish was preserved in a 95% solution of ethyl alcohol to determine hatchery or wild origin using PBT. Hatchery-origin fish were aged using PBT, while fish of unknown origin were assigned ages with sex-specific age–length keys developed using scale-aged fish from 2010 to 2014.

The Chapman–Robson estimator was used to estimate instantaneous total mortality (Z) for each year in the time series via the recommendations of Smith et al. (2012). As with other catch-curve methods, assumptions included the following: (1) the proportion of ages in the population is estimated without error, (2) recruitment varies without trend for all age-classes, (3) mortality is stationary through time and across age-classes, and (4) all age-classes are equally vulnerable to the sampling gear (Robson and Chapman 1961; Smith et al. 2012). Of the various catch-curve methods, the Chapman–Robson estimator is the most

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TABLE 1. Number of hatchery-origin Striped Bass stocked into the Neuse River, North Carolina, and exploitation and environmental factors.

Year	Number stocked	Commercial effort (trips)	Commercial harvest (kg)	Summer dissolved oxygen (mg/L)	Summer water temperature (°C)
1994	182,990	2,531	3,760	7.1	27.5
1995	99,176	2,601	1,792	6.7	26.9
1996	200,760	3,018	3,159	6.5	28.0
1997	100,000	3,084	2,424	8.6	27.8
1998	290,925	3,209	2,511	6.3	27.9
1999	100,000	2,527	2,764	9.0	28.9
2000	229,993	3,030	2,181	6.6	27.3
2001	103,000	2,619	3,149	6.8	27.7
2002	147,654	3,317	1,869	9.5	29.1
2003	100,000	3,196	2,621	6.4	28.1
2004	268,011	2,159	3,547	7.3	28.5
2005	114,000	2,305	2,346	9.1	29.9
2006	245,935	2,777	3,216	7.7	28.1
2007	242,835	2,893	3,053	8.8	28.8
2008	313,798	1,980	2,190	9.7	29.6
2009	204,289	2,464	3,758	7.9	28.2
2010	107,142	1,583	5,092	8.0	30.1
2011	102,089	1,485	7,081	7.8	29.1
2012	140,358	1,577	1,946	6.2	27.8
2013	295,161	2,206	5,328	5.9	27.0
2014	158,730	1,603	2,801	6.7	28.2
2015	109,144	1,091	3,793	6.1	27.8

robust to violations of these assumptions (Murphy 1997; Smith et al. 2012). In accordance with Smith et al. (2012), age at full recruitment to the catch curve was the age of peak catch plus 1 year (peak-plus criterion). In addition, an overdispersion parameter c (Burnham and Anderson 2002; Smith et al. 2012) was calculated for each year to correct the SE of the mortality estimate and to assess structural fit of the Chapman–Robson estimator to the age-structure data ($c > 4$ indicates poor model fit; Burnham and Anderson 2002). Instantaneous fishing mortality was calculated for each year by subtracting instantaneous natural mortality ($M = 0.24$; Bradley 2016) from Z. Uncertainty in the mortality estimates was characterized by calculating the relative standard error (RSE; Z/SE) and bootstrapping from the distributions of Z and M (Gamma distributed; Bolker 2008) to estimate 90% confidence intervals for F.

Mortality modeling.— Linear models were developed to evaluate environmental and exploitation factors that potentially influence discrete annual mortality ($A = 1 - e^{-Z}$) over the time series 1994–2015, including summer dissolved oxygen, summer water temperature, gill-net effort, and commercial harvest. We hypothesized that low dissolved oxygen and warm summer temperatures may lead to increased natural mortality. Hypoxic conditions can be prevalent in the Neuse River estuary during the summer months as a result of nutrient loading and water column stratification (Luettich et al. 2000; NCDENR 2001). These hypoxic conditions have been implicated in many of the 236 fish kills occurring between 1996 and 2015, which primarily affected Atlantic Menhaden *Brevoortia tyrannus* in the Neuse River basin (NCDENR 2001; NCDEQ 2015). Hypoxic events and resulting fish kills have also been implied as negatively affecting Striped Bass (NCDENR 2013). Water quality data were obtained from the Neuse River Estuary Modeling and Monitoring Project (ModMon; UNC 2016), which is one of the few programs that has continuously monitored water quality in the lower Neuse River since 1994. The summer (June–August) mean surface dissolved oxygen (mg/L) and summer mean surface water temperature (°C) at ModMon station 30 (RKM 57; Figure 1) were used as environmental factors. Results of an acoustic telemetry study (Bradley et al. 2018) determined that the highest densities of adult and juvenile Striped Bass occur in the vicinity of the selected ModMon station.

In addition to the suite of environmental factors, several long-term data sets were available from NCDMF to allow investigation of the effects of exploitation. Beginning in 1994, a mandatory trip ticket program was implemented to monitor commercial landings at the first point of sale. Information collected by this program includes harvest (kg) landed by species, gear type, and location (NCDENR 2013). Neuse River Striped Bass commercial

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harvest was used as a direct exploitation factor (NCDMF, unpublished data). However, gill-net fisheries continue to pursue other marketable species after the Striped Bass harvest season is closed. Therefore, the annual number of gill-net trips in the Neuse River was used as a measure of gill-net effort that potentially accounts for harvest, discard, and unreported or misreported mortality (NCDMF, unpublished data). Unfortunately, measures of recreational fishing effort for Striped Bass were not available for the entire time series. A recreational creel survey has been conducted annually in the lower Neuse River since 2004, yet there is limited information for prior years (for exceptions, see Borawa 1983 and Rundle et al. 2004). Several recreational fishing surveys administered by National Oceanic and Atmospheric Administration Fisheries, including the Marine Recreational Information Program, the Marine Recreational Fisheries Statistics Survey, and the Coastal Household Telephone Survey, were investigated for potential use as a surrogate recreational fishing effort metric. However, these surveys lacked the data resolution necessary to specifically assess Neuse River recreational fisheries.

Since age-structure collections occurred in the spring (March–May), it was likely that factors occurring throughout the previous year (gill-net effort) or during the previous summer (dissolved oxygen and surface water temperature) had a greater influence on the estimated mortality rate than same-year measures. Therefore, these predictor variables were modeled using a 1-year time lag. Commercial harvest was not modeled with a time lag since the commercial Striped Bass harvest season occurs in the early spring before electrofishing collections on the spawning grounds; any effects of commercial harvest should be detected using same-year measures. Striped Bass discrete annual mortality was nonstationary; the global model was of the form

$$A'_t = \beta_0 + \sum(\theta_i x'_{i,t-1}) + \theta_C X'_{C,t} + \varepsilon_t,$$

where A = discrete annual mortality; β_0 = intercept; X = variable i; θ_i = effect of variable X_i; t = year; C = commercial harvest; and ε = an independently and identically distributed white noise vector. Note that A'_t and $X'_{i,t}$ were first-differenced to ensure stationarity and remove serial correlation as given by

$$A'_t = A_t - A_{t-1}, \text{and } X'_{i,t} = X_{i,t} - X_{i,t-1}.$$

In the case of four predictor variables, there are 15 main-effects models and 26 total models if we consider first-order interactions. Given our small sample size (22 observations) and the potential for "too many models" (Anderson and Burnham 2002; Burnham et al. 2011; Dochtermann and Jenkins 2011), we did not consider all-subsets regression. Instead, we constrained our analyses to 12 main-effects models (example R code provided in the Supplement available separately online) incorporating dissolved oxygen, surface water temperature, gill-net effort, and commercial harvest using the information-theoretic framework described by Burnham and Anderson (2002). The second-order Akaike's information criterion (AIC$_c$) was computed for each model, and the difference in AIC$_c$ value (Δ_i) from the model with the smallest AIC$_c$ was used to assess the relative strength of the models. After ensuring that A' and X' differencing removed time trends ($\beta_0 = 0$; $\alpha = 0.05$), the intercept was removed from final models, and AIC$_c$ and Δ_i were recalculated. The reduced parameterization improved AIC$_c$ for all models. Akaike weights (ω_i) were calculated to evaluate the relative likelihood of each model (Burnham and Anderson 2002). The relative importance of each predictor variable was assessed by decomposing global model variance using the Lindeman–Merenda–Gold (LMG) method (Grömping 2007). Model-averaged estimates of the effect of each predictor variable were calculated by multiplying the coefficients of each factor in the models in which they appeared by the ω_i of that model (Burnham and Anderson 2002). The model-averaged effect for gill-net effort and commercial harvest was multiplied by the 1994–2015 mean number of gill-net trips and mean harvest, respectively, to estimate each factor's long-term average effect on discrete annual mortality ($\Delta A \equiv u$; discrete annual fishing mortality). Linear models were fitted using ordinary least-squares (OLS) regression with package "dynlm" in R version 3.2.5.

Model assumptions.— Assumptions for OLS time series regression depart in some respects from those considered in classical linear modeling. Assumptions of time series regression include a mean of zero, constant variance, and constant covariance structure through time (stationarity; Hyndman and Athanasopoulos 2014). The augmented Dickey–Fuller (ADF) test ($\alpha = 0.05$; Hyndman and Athanasopoulos 2014) assumes H_0 = nonstationary and was employed in the R package "stats" to assess stationarity in the mortality time series. The partial autocorrelation function (PACF; Derryberry 2014) in the "stats" package was utilized to examine the potential for autocorrelation in the spawning stock discrete annual mortality time series. Multicollinearity among the predictor variables was assessed by calculating variance inflation factors (VIFs; Fox and Weisberg 2011) in the R package "car." Variance inflation factors are generally considered to indicate the presence of multicollinearity if any VIF exceeds 10 (see O'Brien 2007).

RESULTS

Mortality Estimation

The number of Striped Bass collected on the spawning grounds varied throughout the time series, ranging from

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TABLE 2. Chapman–Robson mortality estimator metrics and mortality rates (Z = instantaneous total mortality rate; A = discrete annual mortality; F = instantaneous fishing mortality rate; u = discrete annual exploitation rate) for Neuse River Striped Bass, 1994–2015 (N = total catch; N_c = number in catch curve; T_c = age at recruitment to catch curve [peak-plus]; c = overdispersion parameter; LCL = lower 90% confidence limit; UCL = upper 90% confidence limit; RSE = relative standard error).

	Year of sample																					
Metric	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
N	120	221	226	143	219	292	357	155	102	403	90	125	58	172	141	373	141	176	144	341	311	239
N_c	36	107	71	81	148	151	111	69	67	98	48	97	21	96	24	231	71	55	67	106	129	95
T_c	7	5	6	5	4	5	5	5	4	6	6	4	4	4	6	4	4	5	4	5	5	5
c	0.57	1.60	1.10	2.23	1.64	1.97	4.17	3.90	5.53	2.20	0.12	1.81	1.57	2.52	3.19	4.96	0.13	2.41	0.85	0.42	1.51	0.90
Z	1.08	0.73	0.85	0.61	0.45	0.75	0.45	0.52	0.36	0.65	0.78	0.44	0.53	0.63	0.98	0.84	0.94	0.84	0.62	0.74	0.86	0.94
SE_c	0.19	0.09	0.11	0.10	0.05	0.09	0.09	0.13	0.10	0.10	0.12	0.06	0.15	0.10	0.37	0.13	0.12	0.18	0.08	0.07	0.10	0.10
Z LCL	0.77	0.58	0.67	0.44	0.37	0.61	0.31	0.32	0.19	0.49	0.59	0.34	0.29	0.46	0.37	0.63	0.75	0.54	0.49	0.62	0.70	0.78
Z UCL	1.39	0.88	1.03	0.77	0.53	0.90	0.60	0.73	0.53	0.82	0.97	0.54	0.77	0.80	1.59	1.05	1.13	1.14	0.75	0.87	1.02	1.11
RSE (%)	17	12	13	17	11	12	20	24	29	15	15	14	28	16	38	15	12	22	12	10	11	11
A	0.66	0.52	0.57	0.45	0.36	0.53	0.36	0.41	0.30	0.48	0.54	0.36	0.41	0.47	0.62	0.57	0.61	0.57	0.46	0.53	0.58	0.61
A LCL	0.54	0.44	0.49	0.35	0.31	0.45	0.26	0.27	0.17	0.39	0.44	0.29	0.25	0.37	0.31	0.47	0.53	0.42	0.39	0.46	0.50	0.54
A UCL	0.75	0.58	0.64	0.54	0.41	0.59	0.45	0.52	0.41	0.56	0.62	0.42	0.53	0.55	0.80	0.65	0.68	0.68	0.53	0.58	0.64	0.67
F	0.84	0.48	0.61	0.36	0.21	0.51	0.21	0.28	0.11	0.41	0.53	0.20	0.28	0.38	0.73	0.59	0.69	0.59	0.37	0.50	0.61	0.70
F LCL	0.49	0.23	0.34	0.10	−0.02	0.25	−0.04	−0.01	−0.15	0.15	0.26	−0.03	0.02	0.11	0.17	0.31	0.43	0.25	0.12	0.26	0.36	0.44
F UCL	1.20	0.71	0.86	0.60	0.38	0.73	0.43	0.55	0.36	0.64	0.79	0.39	0.59	0.61	1.44	0.86	0.95	0.96	0.58	0.70	0.84	0.93
u	0.51	0.34	0.41	0.27	0.17	0.36	0.17	0.22	0.10	0.30	0.37	0.16	0.22	0.28	0.47	0.40	0.45	0.40	0.28	0.35	0.41	0.45

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58 fish in 2006 to 403 fish in 2003 (Table 2). Scale ages were reasonably precise, as scale readers had a high rate of agreement within 1 year of age (87–100%; NCWRC, unpublished data). Recruitment to the catch curve typically occurred at age 4 or age 5. Although the oldest Striped Bass encountered on the spawning grounds was an age-13 female collected in 2005, only 73 (1.6%) of the 4,549 fish collected during the time series were age 9 or older.

The Chapman–Robson mortality estimator generally performed well, as c was greater than 4 in only 3 of 22 years (Table 2). Mortality estimates were reasonably precise (RSE < 30%) and only exhibited a high degree of uncertainty in 2008. Instantaneous total mortality Z varied considerably throughout the time series, ranging from 0.36 to 1.08. Mortality was generally lowest during 1997–2007 and highest during 2008–2011. Values of F ranged from 0.12 to 0.84 (Table 2; Figure 2), assuming that the M given by Bradley (2016) remained constant throughout the time series. Fishing mortality was greater than $F_{Threshold}$ in 12 of the 22 years.

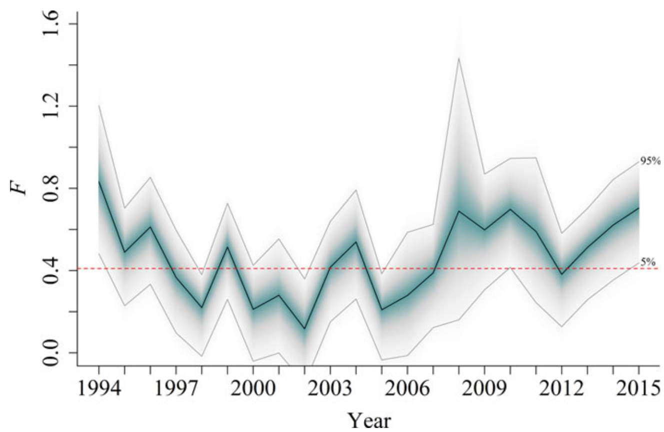

FIGURE 2. Striped Bass spawning stock fishing mortality (F) in the Neuse River, North Carolina, during 1994–2015. The 90% confidence interval is denoted by gray lines, while the interquartile range is within a green color gradient. The dashed red line represents the overfishing threshold ($F_{Threshold}$ = 0.41).

Mortality Modeling

Model assumptions.— The ADF test indicated that spawning stock discrete annual mortality was nonstationary (P = 0.181). Therefore, all modeled variables were first-differenced (Hyndman and Athanasopoulos 2014). The PACF indicated a correlation of 0.34 between A_t and A_{t-1}, suggesting weak autocorrelation. We did not consider this level of autocorrelation sufficient to warrant modeling as a first-order autoregressive process given the small sample size and the potential for model overspecification. The VIFs ranged from 1.1 to 2.5, indicating a low likelihood of multicollinearity among predictor variables.

Model results.— The best linear model supported by the data contained gill-net effort and commercial harvest as predictors of discrete annual mortality (Table 3). The global model containing all predictor variables accounted for 55% of the variability in spawning stock mortality, while the best model accounted for 50%. Every model receiving at least modest support as the best model (Δ_i < 7) incorporated gill-net effort as a predictor variable.

Gill-net effort was the most important predictor of spawning stock mortality relative to the four predictor variables examined (Table 4; Figure 3). Commercial harvest was the second most important predictor of spawning stock mortality, while summer dissolved oxygen and

TABLE 3. Linear models exploring the effect of environmental and exploitation factors on Striped Bass spawning stock discrete annual mortality, 1994–2015 (EFFORT = gill-net effort; DO = dissolved oxygen; HARV = commercial harvest; TEMP = surface water temperature). The number of estimated model parameters (K) includes the predicting factors and an error term; final model runs did not include an intercept parameter. Akaike's information criterion (AIC_c), Akaike difference (Δ_i), Akaike weight (ω_i), and R^2 are presented.

Model	K	AIC_c	Δ_i	ω_i	R^2
EFFORT, HARV	3	−39.95	0.00	0.64	0.50
EFFORT	2	−36.98	2.97	0.15	0.34
EFFORT, HARV, DO, TEMP	5	−34.88	5.07	0.05	0.55
EFFORT, DO	3	−34.81	5.14	0.05	0.36
EFFORT, TEMP	3	−34.60	5.36	0.04	0.35
EFFORT, DO, TEMP	4	−34.40	5.56	0.04	0.44
HARV	2	−31.68	8.27	0.01	0.14
DO	2	−30.67	9.29	0.01	0.09
HARV, DO	3	−30.38	9.57	0.01	0.20
HARV, TEMP	3	−29.83	10.12	0.00	0.10
DO, TEMP	3	−27.98	11.97	0.00	0.10
HARV, DO, TEMP	4	−27.23	12.72	0.00	0.20

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surface water temperature did not substantially influence spawning stock mortality (Tables 3, 4). Multiplying the model-averaged gill-net coefficient by the mean number of gill-net trips for 1994–2015 (2,421 trips) suggests the gill-net fishery mean discrete annual exploitation rate (*u*) was 0.29. Using the same procedure for commercial harvest (3,199 kg) suggests commercial harvest *u* is 0.08.

DISCUSSION

Catch-curve methodologies recommended by Smith et al. (2012) considerably reduced uncertainty in the *Z*-estimates compared to previous Neuse River stock assessments. The SEs of *Z* in our study ranged from 0.05 to 0.37, compared to 0.06–0.61 in the most recent stock assessment (Table 11 in NCDENR 2013). Similarly, RSE exceeded 30% in only 1 of the 22 years in our study, compared to 13 of the 16 years in the previous stock assessment (NCDENR 2013).

The catch-curve analysis indicates that the Neuse River Striped Bass spawning stock has been subjected to overfishing throughout much of the last two decades. The 22-year mean *F* in this study ($F = 0.46$) is similar to the 18-year mean rate ($F = 0.47$) that preceded the depletion of Albemarle Sound/Roanoke River Striped Bass in the 1970s (Hassler et al. 1981; NCDENR 2013). These high *F*-values also approach the level of exploitation that was deemed a major factor in the Atlantic Striped Bass stock

TABLE 4. Relative importance of predictor variables affecting Striped Bass spawning stock mortality (Lindeman–Merenda–Gold [LMG] method).

Predictor variable	Model-averaged coefficient θ	Model-averaged coefficient SE	Relative importance (LMG)
Gill-net effort	1.21×10^{-4}	3.54×10^{-5}	0.62
Commercial harvest	2.37×10^{-5}	1.00×10^{-5}	0.23
Dissolved oxygen	-1.73×10^{-2}	1.63×10^{-2}	0.10
Surface water temperature	2.50×10^{-2}	2.71×10^{-2}	0.05

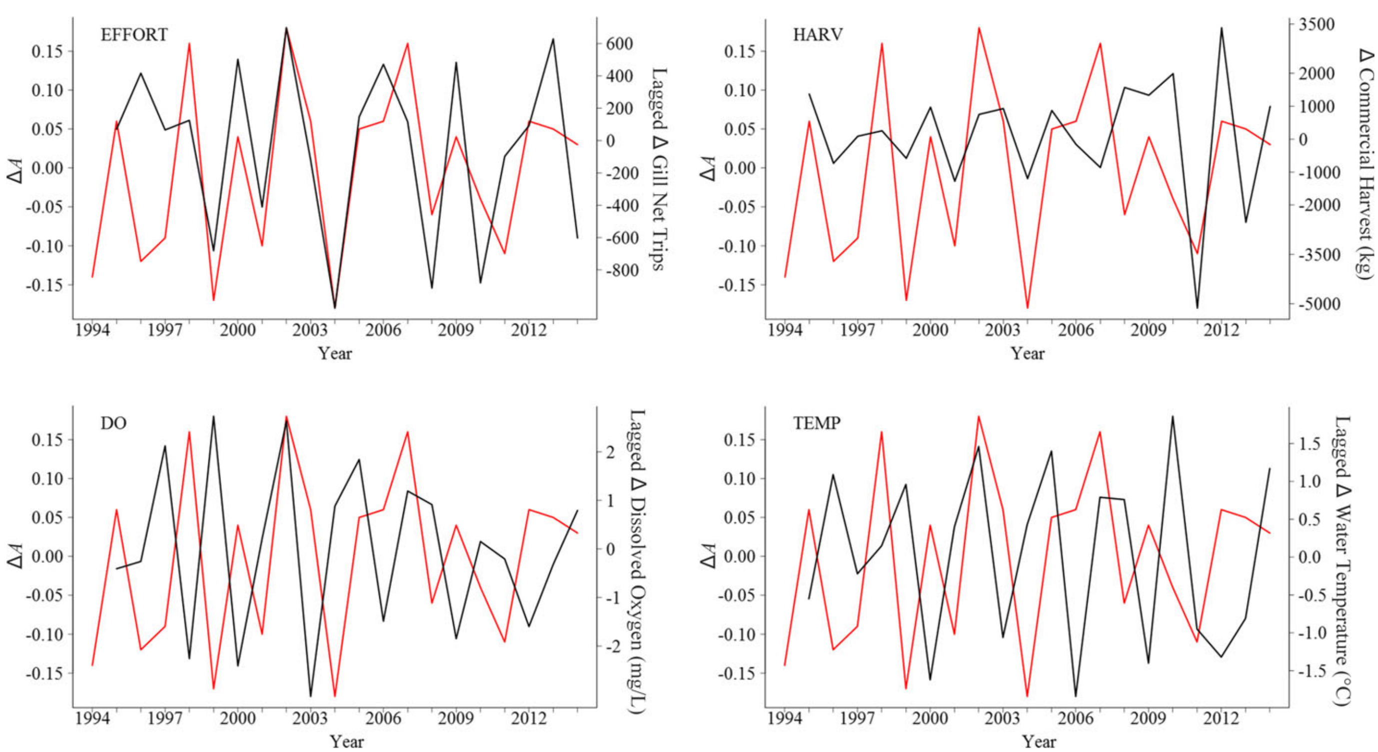

FIGURE 3. Differenced (Δ) Striped Bass spawning stock discrete annual mortality (*A*; red) and differenced exploitation and environmental predictor variables (black) in the Neuse River, North Carolina (EFFORT = gill-net effort; DO = summer mean surface dissolved oxygen; HARV = commercial harvest; TEMP = summer mean surface water temperature). Gill-net effort, DO, and TEMP were modeled with 1-year time lags.

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collapse (ASMFC 1989; Richards and Rago 1999). Mortality has not trended toward F_{Target} despite the development of two comprehensive management plans and increasingly restrictive recreational and commercial harvest regulations (see Appendix 14.5 in NCDENR 2013).

Linear modeling indicates that gill-net effort is the most important factor influencing spawning stock mortality among the exploitation and environmental factors examined. Gill-net effort accounted for substantially greater variability in spawning stock mortality than commercial harvest, and the model-averaged coefficient identified a discrete annual exploitation rate of 0.29 for gill net effort. This suggests that the commercial multispecies gill-net fishery imparts substantial mortality even when the Striped Bass harvest season is closed. The reason for this mortality is obscure, but it may be attributable to dead discard mortality; over-quota and high-grading mortality; avoidance, predation, and drop-out mortality; or unreported, misreported, and illegal harvest (ICES 1995; Gilman et al. 2013; Batsleer et al. 2015; Uhlmann and Broadhurst 2015). In particular, discard mortality should be carefully considered, as Clark and Kahn (2009) found that Striped Bass are acutely susceptible to discard mortality in multispecies gill-net fisheries. Furthermore, Striped Bass discards in the large-mesh gill-net fishery were identified as the primary source of mortality within the CSMA (NCDENR 2013). The effect of gill-net effort on discrete annual mortality as estimated by linear modeling was within 3% of the estimated effect of cryptic mortality in a cohort-based model ($u = 0.26$; Table B.3 in Rachels and Ricks 2015), while the effect of commercial harvest was identical to the estimated discrete annual fishing mortality rate from commercial harvest in that study.

Contrary to exploitation factors, the environmental factors examined did not account for much variability in spawning stock mortality. Bradley et al. (2018) also failed to detect a relationship between dissolved oxygen, water temperature, and Striped Bass mortality between summer 2014 and summer 2015. Although numerous Atlantic Menhaden fish kills have occurred due to hypoxic conditions throughout the time period encompassing our research, it appears that these events have relatively little impact on Striped Bass spawning stock mortality. Campbell and Rice (2014) observed that estuarine fish can rapidly detect and avoid hypoxic areas in the Neuse River. However, they also found that habitat compression due to hypoxic conditions likely reduced growth rates in juvenile Spot *Leiostomus xanthurus* and Atlantic Croaker *Micropogonias undulatus*. Neuse River Striped Bass exhibit the fastest growth rates among coastal North Carolina Striped Bass populations (Rachels and Ricks 2015). It is likely that negative impacts of hypoxic conditions or water temperatures exceeding Striped Bass thermal optima would manifest through reduced growth rates before mortality effects are observed. Nonetheless, the parameter coefficients for summer mean dissolved oxygen and summer mean surface water temperature indicate the potential for increased spawning stock mortality as dissolved oxygen decreases and water temperature increases. These effects were minimal—approximately 2% change in discrete annual mortality per unit change in temperature or dissolved oxygen—compared to the cumulative effects of gill-net effort and commercial harvest.

The inability to include recreational angling as an exploitation factor reduces the amount of variability in spawning stock mortality that can be accounted for in this study. The median annual recreational harvest during 2004–2015 was 2,337 kg and is similar to the median commercial harvest of 3,355 kg for the same time period (NCDMF, unpublished data). Thus, the actual commercial harvest and recreational harvest exploitation rates are similar, an observation supported by simulation studies (Rachels and Ricks 2015; Bradley 2016). It is likely that inclusion of factors that represent recreational harvest and discard would perform comparably to the results of the commercial harvest factor used in linear modeling. However, time-dynamic trends in the level of recreational fishing effort or harvest could influence its importance relative to commercial harvest in a regression analysis. In fact, recreational effort declined dramatically during 2005–2010, concurrent with increases in discrete annual mortality. The continued collection of recreational creel survey data is warranted to elucidate long-term effects of angling on Neuse River Striped Bass mortality.

Since the population is supported almost entirely by hatchery-origin fish, changes to stocking practices may affect recruitment and mortality estimation. Although the annual stocking goal is 100,000 phase-II (160–200 mm TL) Striped Bass, the actual stocking rate (Table 1) has varied (coefficient of variation = 46%) and has included phase-I fish (50 mm TL) in some years. Survival rates of phase-I and phase-II Striped Bass may be similar. Stocking practices in the nearby Cape Fear River are the same as those in the Neuse River, and phase-I and phase-II Striped Bass that were stocked at similar rates contributed almost equally to the Cape Fear River population (NCWRC, unpublished data). Additionally, the effect of variable recruitment on catch-curve mortality estimation has been extensively explored by others. Ricker (1975) determined that recruitment variation up to a factor of 5 did not prohibit catch-curve use so long as the variability was random. Similarly, Allen (1997) found that catch curves were useful for estimating mortality in populations that exhibited higher recruitment variation (55–84%) than the stocking variability observed in our study. Finally, although it does not yield insight into much of the entire time series of our data, our mortality estimates were very

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similar to those reported by Bradley et al. (2018) for 2014–2015. The methodologies used in these studies (telemetry versus age structure) have different underlying assumptions, increasing confidence that mortality during the overlapping time periods was considerable.

Periodic strategists such as Striped Bass are resilient to periods of extended recruitment failure through the storage effect (Warner and Chesson 1985; Winemiller and Rose 1992). Recovery is contingent upon building spawning stock biomass by advancing the female age structure to older, more fecund fish (Secor 2000). Although regulating fishing mortality is one of the principal tools available to fisheries managers, "historical precedence is often invoked as a reason to continue unwise fishery management practices" (Richards and Rago 1999). However, the effectiveness of coordinated multi-jurisdictional management efforts in significantly reducing exploitation has been demonstrated by the restoration of the Atlantic Striped Bass stock (Field 1997; Richards and Rago 1999).

Current high exploitation rates combined with low stock abundance and a high contribution of hatchery fish to the spawning stock (Rachels and Ricks 2015; Bradley et al. 2018) suggest that the expected recovery time of Neuse River Striped Bass continues to be "both uncertain and long" (Hilborn et al. 2014). Our research indicates that fisheries managers should reduce exploitation by focusing on reductions in gill-net effort in areas of the Neuse River that are utilized by Striped Bass. Reducing spawning stock exploitation may confer an increased likelihood of recruitment during periods of favorable environmental conditions, thereby leading to improvements in population abundance and increased numbers of wild fish in the spawning stock.

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SUPPORTING INFORMATION

Additional supplemental material may be found online in the Supporting Information section at the end of the article.

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ROY COOPER
Governor

MICHAEL S. REGAN
Secretary

STEPHEN W. MURPHEY
Director

Oct. 30, 2020

MEMORANDUM

TO: N.C. Marine Fisheries Commission

FROM: Laura Lee, Lead Stock Assessment Scientist
Charlton Godwin, Biologist Supervisor, Estuarine Striped Bass FMP Co-Lead
Fisheries Management Section

SUBJECT: Updates on 2020 Benchmark Albemarle-Roanoke Striped Bass Stock Assessment, Adaptive Management under Amendment 1 of the Estuarine Striped Bass FMP, and Amendment 2 Development

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Issue

Review of the N.C. Estuarine Striped Bass Fishery Management Plan (FMP) is underway. To begin review of Amendment 2 to the FMP the division and Wildlife Resources Commission (WRC) staff conducted a stock assessment of Albemarle-Roanoke (A-R) striped bass. This memo provides a summary of: 1) results for the 2020 benchmark A-R striped bass stock assessment, 2) information on adaptive management contained in Amendment 1 and the 2020 Revision to the N.C. Estuarine Striped Bass FMP, and 3) progress towards developing Amendment 2.

Findings

- The benchmark A-R stock assessment passed an external peer review process in June of 2020. Results showed the A-R striped bass stock is overfished and overfishing is occurring in the terminal year (2017) of the assessment.
- Adaptive management contained in Amendment 1 to the N.C. Estuarine Striped Bass FMP states: "*should the target F [fishing mortality] be exceeded, then restrictive measures will be imposed to reduce F to the target level*".
- Target F has been exceeded triggering the Revision to Amendment 1 implementing restrictive measures to reduce F to the target.
- Beginning in January 2021 a reduction in the A-R striped bass total allowable landings (TAL) to 51,126 lb will be implemented and will remain in place until the adoption of Amendment 2.
- The division is planning an update to the stock assessment in 2023 with data through 2022 to reassess stock conditions.
- Adequate river flows and sufficient spawning stock biomass (SSB) are both needed for successful spawning. Even at high levels of SSB, if river flows during the spawning season are not within recommended ranges successful spawning will not occur, which in turn leads to population decline regardless of the amount of fishing mortality (*F*).

Action Needed

For informational purposes only, **no action is needed at this time.**

State of North Carolina | Division of Marine Fisheries
3441 Arendell Street | P.O. Box 769 | Morehead City, North Carolina 28557
252-726-7021

Overview

Results from the 2020 benchmark Albemarle-Roanoke Striped Bass Stock Assessment

Results from the 2020 benchmark A-R stock assessment indicate the stock is overfished and overfishing is occurring. Benchmark assessments involve a full analysis and review of the stock, including consideration of data inputs, new or improved assessment models, and recalculation of the Biological Reference Points (BRPs). The BRPs for this assessment are listed below in Table 1, along with the estimates of fishing mortality and spawning stock biomass from the terminal year of the assessment. The estimate of fishing mortality (*F*) in the terminal year of the assessment (2017) was 0.27, which is above the F Threshold of 0.18. The estimate of SSB was 78,576 lb, which is below the SSB Threshold of 267,390 lb.

Table 1. Biological reference points (BRPs) and the 2017 estimate of fishing mortality (*F*) and spawning stock biomass (SSB) from the 2020 Albemarle-Roanoke striped bass benchmark assessment.

Biological Reference Points (lb)		**Terminal Year (2017) Estimate**
F Target	0.13	*F* = 0.27
F Threshold	0.18	
SSB Target	350,371 lb	SSB = 78,576 lb
SSB Threshold	267,390 lb	

Adaptive Management actions required under Amendment 1 to the N.C. Estuarine Striped Bass FMP to lower fishing mortality to the target

Implementing a new lower harvest level accomplishes the adaptive management directive in Amendment 1 to the North Carolina Estuarine Striped Bass FMP and maintains compliance with ASMFC's Addendum IV to Amendment 6 to the Interstate FMP for Atlantic Striped Bass. This same directive resulted in the November 2014 Revision to Amendment 1 that reduced the TAL from 550,000 lb to 275,000 lb based on projections starting from the terminal year (2013) of the then most recent assessment.

The Revision to Amendment 1 will be implemented a lower TAL effective January 2021 to reduce *F* to the *F* target. A 57% reduction in total removals relative to 2017 total removals is needed to bring *F* back to the *F* target and discards are already accounted for in the landings calculation. Total removals in 2017 included 119,244 lb of harvest and 23,795 lb of discards. Table 2 shows the TAL required to bring *F* back to the target in one year. During 2021 and 2022, harvest for the Albemarle-Roanoke fisheries will be monitored and controlled to keep harvest below the 51,216 lb TAL.

Table 2. The total allowable landings (TAL) necessary to reduce fishing mortality back to the target. Implementation date January 1, 2021.

Total Allowable Landings	**51,216 lb**
Fleet	**TAL (lb)**
ASMA commercial	25,608 lb
ASMA recreational	12,804 lb
RRMA recreational	12,804 lb

River flow and population decline

One important factor to note, which was pointed out by the peer reviewers, is it appears there are other reasons for the decline in SSB other than just removals due to fishing. Poor recruitment (the number of age-0 fish coming into the population each year) could be the main reason for the population decline. Flow on the Roanoke River during egg and larval development during the month of May plays an important role in successful year-class production. Flows that are low to moderate are favorable for abundant year-class production while very high flows are almost always detrimental to year-class production because larvae flow out of the banks of the river into the floodplain where survival is low. After many years of above-average recruitment (1993-2000), the population experienced several poor and missing year classes (2003, 2004, 2009, 2013), and four recent poor year classes (2017, 2018, 2019 and again in 2020). It is apparent from the results of fishery-independent monitoring and results from the stock assessment that even in years when SSB is well above the SSB target, if flows are not within the recommended range, successful spawning will not occur. In short, adequate flows and sufficient SSB are both needed for successful spawning. It is also evident from previous stock performance and results from the most recent assessment, that SSB levels can increase dramatically with just a couple of years of successful spawning events .

Amendment 2 to the N.C. Estuarine Striped Bass FMP

The November 2020 Revision to Amendment 1 to the N.C. Estuarine Striped Bass FMP is separate from and will not impede timing of the development of Amendment 2. Development of Amendment 2 is ongoing. The scoping period was Nov. 2-15, 2020 and public meetings were held Nov. 5 and 9, 2020. Results of the scoping period, the draft Goals and Objectives of Amendment 2, and a request for any additional management strategies to be considered will be brought before the MFC at its February 2021 business meeting. Under the provisions of the Fisheries Reform Act, Amendment 2 management strategies for the Albemarle-Roanoke stock will be adopted to address the overfished/overfishing condition. Adaptive management measures are also likely to be included in Amendment 2 to provide needed flexibility to account for changing stock conditions. The division is planning an update to the stock assessment in 2023 with data through 2022 to reassess stock conditions and update the TAL.

For more information, please refer to the full documents included in the briefing materials:

- Assessment of the Albemarle Sound-Roanoke River Striped Bass (*Morone saxatilis*) in North Carolina, 1991-2017
- November 2020 Revision to Amendment 1 to the N.C. Estuarine Striped Bass Fishery Management Plan
- Scoping document for Amendment 2 to the N.C. Estuarine Striped Bass Fishery Management Plan

Assessment of the Albemarle Sound-Roanoke River Striped Bass (*Morone saxatilis*) in North Carolina, 1991–2017

L.M. Lee, T.D. Teears, Y. Li, S. Darsee, and C. Godwin (editors)

August 2020

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EXECUTIVE SUMMARY

The North Carolina Fisheries Reform Act requires that fishery management plans be developed for the state's commercially and recreationally important species to achieve sustainable levels of harvest. Stock assessments are the primary tools used by managers to assist in determining the status of stocks and developing appropriate management measures to ensure the long-term viability of stocks.

The Albemarle Sound-Roanoke River (A-R) striped bass stock is managed jointly by the North Carolina Division of Marine Fisheries (NCDMF), the North Carolina Wildlife Resources Commission (NCWRC), and the South Atlantic Fisheries Coordination Office (SAFCO) of the U.S. Fish and Wildlife Service (USFWS) under guidelines established in the Atlantic States Marine Fisheries Commission (ASMFC) Interstate Fishery Management Plan (FMP) for Atlantic Striped Bass and the North Carolina Estuarine Striped Bass FMP. The Albemarle Sound Management Area (ASMA) includes Albemarle Sound and all of its joint and inland water tributaries, (except for the Roanoke, Middle, Eastmost, and Cashie rivers), Currituck Sound, Roanoke and Croatan sounds and all of their joint and inland water tributaries, including Oregon Inlet, north of a line from Roanoke Marshes Point to the north point of Eagle Nest Bay. The Roanoke River Management Area (RRMA) includes the Roanoke River and its joint and inland water tributaries, including Middle, Eastmost, and Cashie rivers, up to the Roanoke Rapids Lake Dam.

A forward-projecting statistical catch-at-age model was applied to data characterizing landings/harvest, discards, fisheries-independent indices, and biological data collected from the 1991 through 2017 time period. Both observed recruitment and model-predicted recruitment have been relatively low and declining in recent years. Fisheries-dependent and fisheries-independent data indicate a truncation of both length and age structure in recent years.

Reference point thresholds for the A-R striped bass stock were based on 35% spawner potential ratio (SPR). The estimated threshold for female spawning stock biomass (SSB; $SSB_{Threshold}$ or $SSB_{35\%}$) was 121 metric tons. Terminal year (2017) female SSB was 35.6 metric tons, which is less than the threshold value and suggests the stock is currently overfished ($SSB_{2017} < SSB_{Threshold}$). The female SSB target (SSB_{Target} or $SSB_{45\%}$) was 159 metric tons. The assessment model estimated a value of 0.18 for the threshold fishing mortality ($F_{Threshold}$ or $F_{35\%}$). The estimated value of fishing mortality in the terminal year (2017) of the model was 0.27, which is greater than the threshold value and suggests that overfishing is currently occurring in the stock ($F_{2017} > F_{Threshold}$). The fishing mortality target (F_{Target} or $F_{45\%}$) was estimated at a value of 0.13.

An independent, external peer review of this stock assessment approved the stock assessment for use in management for at least the next five years.

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1 INTRODUCTION

1.1 The Resource

The common and scientific names for the species are striped bass, *Morone saxatilis* (Artedi et al. 1792). In North Carolina it is also known as striper, rockfish, or rock. Striped bass naturally occur in fresh, brackish, and marine waters along the western Atlantic coast from Canada to Florida, and through the U.S. coast of the Gulf of Mexico. Striped bass are anadromous, conducting annual spawning migrations in the spring of each year up to the fall line in freshwater tributaries. In addition, after spawning portions of the stocks from the Albemarle Sound-Roanoke River, Chesapeake Bay, Delaware Bay, and the Hudson River migrate along the Atlantic coast north in the summer and south in the winter. The stocks from the Chesapeake Bay constitute the majority of this migrating population. Due to these facts, striped bass have been the focus of fisheries from North Carolina to New England for several centuries and have played an integral role in the development of numerous coastal communities (ASMFC 1998). Striped bass regulations in the United States date to colonial times; in 1639 the Massachusetts Bay colony passed a law that prohibited striped bass from being used as fertilizer to promote fishery commerce with Europe (Hutchinson, T. [1764] 1936; McFarland 1911).

1.2 Life History

1.2.1 Stock Definitions

There are two geographic management units and four striped bass stocks inhabiting the estuarine and inland waters of North Carolina. The northern management unit is comprised of two harvest management areas: the Albemarle Sound Management Area (ASMA) and the Roanoke River Management Area (RRMA; Figure 1.1). The striped bass stock in the two harvest management areas is referred to as the Albemarle-Roanoke (A-R) stock, and its spawning grounds are located in the Roanoke River in the vicinity of Weldon, NC. The ASMA includes the Albemarle Sound and all its tributaries, (except for the Roanoke, Middle, East-most, and Cashie rivers), Currituck, Roanoke and Croatan sounds and all their tributaries, including Oregon Inlet, north of a line from Roanoke Marshes Point across to the north point of Eagle Nest Bay in Dare county. The RRMA includes the Roanoke River and its tributaries, including Middle, East-most, and Cashie rivers, up to the Roanoke Rapids Lake Dam. Management of recreational and commercial striped bass regulations within the ASMA is the responsibility of the NCDMF. Within the RRMA, commercial regulations are the responsibility of the NCDMF while recreational regulations are the responsibility of the North Carolina Wildlife Resources Commission (NCWRC). The A-R stock is also included in the management unit of Amendment 6 to the Atlantic States Marine Fisheries Commission (ASMFC) Interstate Fishery Management Plan (FMP) for Atlantic Striped Bass (ASMFC 2003).

1.2.2 Movements & Migration

Numerous tagging studies have been conducted on striped bass in North Carolina and along the Atlantic Coast since the 1930s. Several older studies suggest the A-R stock is at least partially migratory, with primarily older adults participating in offshore migrations. Tag-recapture studies (Merriman 1941; Vladykov and Wallace 1952; Davis and Sykes 1960; Chapoton and Sykes 1961; Nichols and Cheek 1966; Holland and Yelverton 1973; Street et al. 1975; Hassler et al. 1981; Boreman and Lewis 1987; Benton, unpublished) indicated that a small amount of offshore

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migration occurs; however, these studies occurred when the stock was experiencing very high exploitation rates and the age structure was truncated. Most of the fish tagged during these early studies were young and male. Recent research on the A-R stock demonstrates that as A-R striped bass get older they migrate out of the ASMA into North Carolina's near shore ocean waters, and then as they continue to age they participate in summertime coastal migrations to northern areas including Chesapeake Bay, Delaware Bay, Hudson Bay, and coastal areas of New Jersey, New York, Rhode Island, and Massachusetts (Callihan et al. 2014). The probability of a six-year-old striped bass (average size 584 mm or 23 inches total length, TL) migrating out of the ASMA is 7.5%. This probability increases with age, and by age 11 (average size 940 mm or 37 inches TL) the probability of migrating outside North Carolina's waters is 72.5%. (Callihan et al. 2014). Callihan et al. (2014) also found that when the total A-R stock abundance is higher there is a greater likelihood that smaller striped bass utilize habitat in the Pungo, Tar-Pamlico, and Neuse rivers and northwestern Pamlico Sound.

1.2.3 Age & Size

Striped bass have been aged using scales for more than 70 years (Merriman 1941). Scales of striped bass collected in North Carolina show annulus formation taking place between late April through May in the Albemarle Sound and Roanoke River (Trent and Hassler 1968; Humphries and Kornegay 1985). Annuli form on scales of striped bass caught in Virginia between April and June during the spawning season (Grant 1974).

Age data have been a fundamental part of assessing A-R striped bass since the first A-R assessment (Gibson 1995). The oldest observed striped bass in the A-R stock to date (in 2017) was 23 years old from the 1994 year class. The fish was originally collected and tagged on the spawning grounds during the 2007 season by the NCWRC, aged to 13 years old and was then recaptured by an angler on June 10, 2017 near Sandy Hook, New Jersey. The fish was 40 inches long and weighed 35 pounds when originally tagged. Historically, Smith (1907) reported several striped bass captured in pound nets in Edenton in 1891 that weighed 125 pounds each. Worth (1904) reported the largest female striped bass taken at Weldon that year for strip spawning weighed 70 pounds. The oldest striped bass observed in the data used for this assessment was 17 years old.

1.2.4 Growth

As a relatively long-lived species, striped bass can attain a moderately large size. Females grow to a considerably larger size than males; striped bass over 30 pounds are almost exclusively female (Bigelow and Schroeder 1953; NCDMF and NCWRC, unpublished data).

Growth rates for the A-R stock are rapid during the first three years of life and then decrease to a slower rate as the fish reach sexual maturity (Olsen and Rulifson 1991). Growth occurs between April and October. Striped bass stop feeding for a brief period just before and during spawning but feeding continues during the upriver spawning migration and begins again soon after spawning (Trent and Hassler 1966). From November through March growth is negligible.

Available annual age data (scales) were fit with the von Bertalanffy age-length model to estimate growth parameters for both female and male striped bass. This model was weighted by the number of data points and applied to fractional ages. Unsexed age-0 fish were included in the fits for both the males and females. Estimated parameters of the age-length model are shown in Table 1.1. Fits to the available data performed well for both females (Figure 1.2) and males (Figure 1.3).

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Parameters of the length-weight relationship were also estimated in this study. The relation of total length in centimeters to weight in kilograms was modeled for males and females separately. Parameter estimates of the length-weight model are shown in Table 1.2. Predicted weight at length performed well based on both the female (Figure 1.4) and male (Figure 1.5) striped bass data.

1.2.5 Reproduction

Striped bass spawn in freshwater or nearly freshwater portions of North Carolina's coastal rivers from late March to June depending on water temperatures (Hill et al. 1989). Peak spawning activity occurs when water temperatures reach 16.7°–19.4°C (62.0°–67.0°F) on the Roanoke River (Rulifson 1990, 1991). Spawning behavior is characterized by brief peaks of surface activity when a mature female is surrounded by up to 50 males as eggs are broadcast into the surrounding water, and males release sperm, termed "rock fights" by locals (Worth 1904; Setzler et al. 1980). Spawning by a given female is probably completed within a few hours (Lewis and Bonner 1966).

1.2.5.1 Eggs

Mature eggs are 1.0–1.5 mm (0.039 to 0.059 inch) in diameter when spawned and remain viable for about one hour before fertilization (Stevens 1966). Fertilized eggs are spherical, non-adhesive, semi-buoyant, and nearly transparent. The incubation period at peak spawning temperatures ranges from 42 to 55 hours. At 20.0°C (68.0°F), fertilized eggs need to drift downstream with currents to hatch into larvae. If the egg sinks to the bottom, its chances of hatching are reduced because the sediments reduce oxygen exchange between the egg and the surrounding water. Hassler et al. (1981) found that eggs hatch in 38 hours. After hatching, larvae are carried by the current to the downstream nursery areas located in the western Albemarle Sound (see section 1.3.3; Hassler et al. 1981).

1.2.5.2 Larvae

Larval development is dependent upon water temperature and is usually regarded as having three stages: (1) yolk-sac larvae are 5–8 mm (0.20 to 0.31 inch) in total length (TL) and depend on yolk material as an energy source for 7 to 14 days; (2) fin-fold larvae (8–12 mm; 0.31–0.47 inch TL) having fully developed mouth parts and persist about 10 to 13 days; and (3) post fin-fold larvae attain lengths up to 30 mm (1.18 inches) TL in 20 to 30 days (Hill et al. 1989). Researchers of North Carolina stocks of striped bass (primarily the A-R stock) divide larval development into yolk-sac and post yolk-sac larvae (Hill et al. 1989; Rulifson 1990). Growth occurs generally within the same rates described above depending upon temperature. At temperatures ≥ 20°C (68°F) larvae develop into juveniles in approximately 42 days (Hassler et al. 1981).

1.2.5.3 Juveniles

Most striped bass enter the juvenile stage at about 30 mm (1.18 inches) TL; the fins are then fully formed, and the external morphology of the young is like the adults. Juveniles are often found in schools and associate with clean sandy bottoms (Hill et al. 1989). Juveniles spend the first year of life in western Albemarle Sound and lower Chowan River nursery areas (Hassler et al. 1981). There is evidence of density-dependent habitat utilization; when large year classes are produced juveniles are collected in early June as far away from the western Albemarle Sound as the lower Alligator River (63 water miles) and Stumpy Point, Pamlico Sound (75 water miles; NCDMF, unpublished data).

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1.2.5.4 Maturation & Fecundity

Early research conducted on the A-R stock indicated that females began reaching sexual maturity in approximately three years, at sizes of about 45.7 cm (18 inches) TL (Trent and Hassler 1968; Harris and Burns 1983; Harris et al. 1984). In the most recent maturation study conducted on a recovered stock with expanded age structure, Boyd (2011) found that 29% of A-R females reached sexual maturity by age 3, while 97% were mature by age 4, and 100% were mature at age 5 (Table 1.3). In general, there is a strong positive correlation between the length, weight, and age of a female striped bass and the number of eggs produced. Boyd (2011) estimated fecundity ranging from 176,873 eggs for an age-3 fish to 3,163,130 eggs for an age-16 fish.

1.2.6 Mortality

1.2.6.1 Natural Mortality

Striped bass are a long-lived species with a maximum age of at least 31 years (Atlantic coastal stock) based on otoliths (Secor 2000), suggesting overall natural mortality is relatively low. Previous assessments have assumed a constant natural mortality (M) of 0.15 across all ages, consistent with Hoenig's (1983) regression on maximum age (ASMFC 2009; NCDMF 2010).

Harris and Hightower (2017) estimated annual total instantaneous natural mortality for striped bass using both an integrated model and a multi-state only model based on VEMCO acoustic, Passive Integrated Transponder, and traditional external anchor tagging data. The integrated model produced a study-wide natural mortality rate of 0.70 while the multi-state only model produced an estimate of 0.74 (average of 0.72 over the two methods). The estimates apply to striped bass ranging in length from 45.8 cm to 89.9 cm (18 inches to 35 inches, approximately 3 to 9 years old).

There are a number of methods available to estimate natural mortality based on life history characteristics. These include approaches based on parameters of the von Bertalanffy age-length relationship (Alverson and Carney 1975; Ralston 1987; Jensen 1996; Cubillos 2003) as well as approaches based on maximum age (Alverson and Carney 1975; Hoenig 1983; Hewitt and Hoenig 2005; Then et al. 2015). Several of these methods were applied to A-R striped bass to produce estimates of age-constant natural mortality for females and males. Values for the life history parameters required by some of these approaches were those estimated in this stock assessment (see section 1.2.4). For approaches that depend on maximum age, a maximum age of 17 was assumed for females and a maximum age of 15 was assumed for males. These maximum ages are based on the maximum ages observed in the available data within the ASMA and RRMA over the assessment time series (1991–2017). Life history-based empirical estimates of age-constant natural mortality ranged from 0.099 to 0.37 for females and from 0.090 to 0.44 for males (Table 1.4).

Natural mortality of long-lived fish species is commonly considered to decline with age, as larger fish escape predation. Several approaches are available to derive estimates of age-varying natural mortality (e.g., Lorenzen 1996, 2005). Here, the Lorenzen (1996) approach was used to produce estimates of M at age. As expected, estimates of M decrease with increasing age (Table 1.5; Figure 1.6).

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1.2.6.2 Discard Mortality

Discards from the commercial gill-net fishery are broken into two categories, live and dead discards as recorded by the observer. Live discards are multiplied by a discard mortality rate, which for gill-net fisheries is estimated at 43% (ASMFC 2007).

Nelson (1998) estimated short-term mortality for striped bass caught and released by recreational anglers in the Roanoke River, North Carolina as 6.4%. Nelson found that water temperature and hooking location were important factors affecting catch-and-release mortality, consistent with previous studies (Harrell 1988; Diodati 1991).

1.2.7 Food & Feeding Habits

Several food habit studies have been conducted for juvenile and adult striped bass since 1955 in the Roanoke River and Albemarle Sound. Studies of juvenile striped bass diets in Albemarle Sound found zooplankton and mysid shrimp as primary prey items in the summer, with small fish (most likely bay anchovies) entering the diet later in the season (Rulifson and Bass 1991; Cooper et al. 1998). Adults feed extensively on blueback herring and alewives in the river during the spawning migration (Trent and Hassler 1968). Manooch (1973) conducted a seasonal food habit study in Albemarle Sound and found primarily fish in the Clupeidae (Atlantic menhaden, blueback herring, alewife, and gizzard shad) and Engraulidae (anchovies) families dominated the diet in the summer and fall. Atlantic menhaden (54%) was the most frequently eaten species and comprised a relatively large percentage of the volume (50%). In the winter and spring months, invertebrates occurred more frequently in the diet (primarily amphipods during the winter and blue crabs in the spring). Similarly, Rudershausen et al. (2005) found a diverse array of fish in the diets of age-1 striped bass whereas the diets of age-2 and age-3+ striped bass were primarily comprised of menhaden in 2002 and 2003 in the Albemarle Sound. Tuomikoski et al. (2008) investigated age-1 striped bass diets in Albemarle Sound where American shad comprised most of their diet in 2002, but yellow perch dominated the diet in 2003. The 2003 year class for yellow perch was one of the highest on record in NCDMF sampling programs, so the high occurrence of yellow perch in striped bass stomachs may not be typical (NCDMF 2010). However, it also supports other research that striped bass exhibit an opportunistic feeding behavior (Rulifson et al. 1982).

From the fall of 1995 through the spring of 2001, stomach contents from 1,796 striped bass collected from the NCDMF Striped Bass Independent Gill-Net Survey were analyzed. Unidentifiable fish parts were the dominant stomach content from western Albemarle Sound samples (35.9%), followed by river herring (33.2%) and Atlantic menhaden (16.5%). The dominance of river herring during the spawning migration supports results reported by Trent and Hassler (1968) and Manooch (1973). Blue crab accounted for 0.2% of the total stomach contents from the western sound. In eastern Albemarle Sound samples, unidentifiable fish parts accounted for 34.0%, followed by Atlantic menhaden (31.5%), Atlantic croaker (12.1%), anchovy spp. (11.1%) and spot (6.5%). Blue crab comprised 2.1% of the stomach contents from the eastern sound.

From the fall of 2001 through the spring 2010, the NCDMF analyzed 4,448 striped bass stomachs having food contents. In western Albemarle Sound samples unidentifiable fish parts accounted for 61.2% of stomach contents, followed by Atlantic menhaden (23.1%), anchovy spp. (4.0%), invertebrates (3.0%), Atlantic croaker (2.5%), and river herring (2.0%). Blue crab accounted for less than 1.0% of stomach contents in western sound samples. It is interesting to note the decline in the prevalence of river herring in striped bass diets in the western sound since 2001. In eastern

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Albemarle Sound samples, unidentifiable fish parts accounted for 41.2% of the stomach contents, followed by Atlantic menhaden (40.8%), anchovy spp. (6.4%), spot (6.4%), and Atlantic croaker (2.9%). Blue crab accounted for less than 1.0% of stomach contents in the eastern sound samples as well.

From 2011 through 2017, the NCDMF analyzed 1,918 striped bass stomachs having contents. In western Albemarle Sound samples, unidentifiable fish parts accounted for 35.9% of stomach contents, followed by Atlantic menhaden (12.6%), Atlantic croaker (10.0%), and Clupeidae species (1.8%). Blue crab accounted for less than 1.0% of stomach contents in western sound samples. In eastern Albemarle Sound samples, unidentifiable fish parts accounted for 19.3% of the stomach contents, followed by Atlantic menhaden (2.4%) and invertebrates (1.7%). Blue crab accounted for less than 1.0% of stomach contents in the eastern sound samples.

1.3 Habitat

1.3.1 Overview

Habitat loss has contributed to the decline in anadromous fish stocks throughout the world (Limburg and Waldman 2009). Striped bass use a variety of habitats as described in the life history section with variations in habitat preference due to location, season, and ontogenetic stage. Although primarily estuarine, striped bass use habitats throughout estuaries and the coastal ocean. Striped bass are found in most habitats identified by the North Carolina Coastal Habitat Protection Plan (CHPP) including: water column, wetlands, submerged aquatic vegetation (SAV), soft bottom, hard bottom, and shell bottom (NCDEQ 2016). Each habitat is part of a larger habitat mosaic, which plays a vital role in the overall productivity and health of the coastal ecosystem. Although striped bass are found in all of these habitats, usage varies by habitat. Additionally, these habitats provide the appropriate physicochemical and biological conditions necessary to maintain and enhance the striped bass population. Therefore, the protection of each habitat type is critical to the sustainability of the striped bass stock.

1.3.2 Spawning Habitat

The main spawning habitat for A-R striped bass is in the Roanoke River in the vicinity of Weldon, NC, around river mile (RM) 130. This is the location of the first set of rapids at the fall line transition between the Coastal Plain and the Piedmont. Historic accounts indicate major spawning activity centered at Weldon (Worth 1904), but striped bass were known to migrate up the mainstem Roanoke River to Clarksville, VA (RM 200; Moseley et al. 1877) and possibly as far as Leesville, VA (RM 290; NMFS and USFWS 2016). Striped bass spawning migrations have been impeded since construction of the initial dam on the mainstem of the Roanoke River at Roanoke Rapids, NC (RM 137) around 1900 (NMFS and USFWS 2016). The dam was approximately 12-feet high (Hightower et al. 1996) and impeded striped bass migrations especially during low flow years. Completion of the John H. Kerr Dam, 42 river miles upstream of Roanoke Rapids Dam, by the U.S. Army Corps of Engineers in 1953 completely blocked access to upriver habitats, and construction of the current Roanoke Rapids Dam by Virginia Electric and Power Company in 1955 and Gaston Dam in 1964 eliminated striped bass usage of the 42 river miles below Kerr Dam (NMFS and USFWS 2016). Spawning activity now ranges from RM 78 to RM 137 with most of the activity occurring between RM 120 and RM 137, still centered around Weldon.

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1.3.3 Nursery & Juvenile Habitat

Juveniles are found in schools; the location of the schools varies considerably with the age of the fish and apparently prefer clean sandy bottoms but have been found over gravel beaches, rock bottoms, and soft mud (Hill et al. 1989). The Roanoke River delta area does not seem to be an important nursery area for YOY striped bass. They appear to spend the first year of life (age-0) growing in and around the western Albemarle Sound and lower Chowan River (Hassler et al. 1981).

As they enter their second and third year, striped bass are found throughout Albemarle Sound and its tributaries. The presence of age-1 and -2 striped bass in the Albemarle Sound Independent Gill-Net Survey confirms this, as well as reports of discarded undersized fish from the striped bass recreational creel survey conducted throughout the Albemarle Sound and its tributaries (NCDMF, unpublished data).

1.3.4 Adult Habitat

Analysis of tagging data indicate younger, smaller adult A-R striped bass (from 35.0–60.0 cm TL) remain in inshore estuarine habitats, while older, larger adults (>60.0 cm TL) are much more likely to emigrate to ocean habitats after spawning; (Callihan et al. 2014). Further, smaller adults show evidence of density-dependent movements and habitat utilization, as the likelihood of recapture outside the ASMA in adjacent systems (i.e., northwestern Pamlico Sound, Tar-Pamlico, Pungo, and Neuse rivers, lower Chesapeake Bay, and the Blackwater and Nottoway rivers in Virginia) increases during periods of higher stock abundance (Callihan et al. 2014).

1.3.5 Habitat Issues & Concerns

Numerous documents have been devoted entirely to habitat issues and concerns, including the North Carolina Coastal Habitat Protection Plan (Street et al. 2005; NCDEQ 2016) and ASMFC's "Atlantic Coast Diadromous Fish Habitat: A review of Utilization, Threats, Recommendations for Conservation, and Research Needs" (Greene et al. 2009). Many contaminants are known to adversely affect striped bass at numerous life stages and can be detrimental to eggs and larvae (Buckler et al. 1987; Hall et al. 1993; Ostrach et al. 2008). Adequate river flows during the spawning season are also needed to keep eggs suspended for proper development (N.C. Striped Bass Study Management Board 1991).

Hassler et al. (1981) indicated that adequate river flow during the pre-spawn and post-spawn periods was the most important factor contributing to survival of fish larvae and the subsequent production of strong or poor year classes.

1.4 Description of Fisheries

Since 2015, the current total allowable landings (TAL) has been set at 124.7 metric tons (275,000 lb) and is split evenly between the commercial and recreational fisheries in the ASMA and RRMA (Table 1.6). In the ASMA, the commercial fishery has a TAL of 62.37 metric tons (137,500 lb) while the ASMA and RRMA recreational fisheries each have a TAL of 31.18 metric tons (68,750 lb). The TAL has changed throughout the previous two decades in response to changes in stock abundance and has ranged from for a low of 71.12 metric tons (156,800 lb) in the early 1990s to 249.5 metric tons (550,000 lb) from 2003 to 2014.

1.4.1 Commercial Fishery

Striped bass are landed commercially in the ASMA primarily with anchored gill nets and to a lesser degree by pound nets. Insignificant landings occur in fyke nets and crab pots. Since 1991, landings in the commercial fishery have ranged from a low of 31.03 metric tons (68,409 lb) in 2013 to a high of 124.2 metric tons (273,814 lb) in 2004 (Table 1.7). Total catch has shown an overall decline since 2004.

1.4.1.1 Historical

The Albemarle Sound area commercial striped bass fishery has been documented in numerous reports for over 100 years. Worth (1884) suggests an industry origin of 1872. During the early 1880s, a large fishery developed on Roanoke Island catching striped bass in the spring and fall (Taylor and White 1992). Gears included haul seines, drag nets, purse seines, fish traps, and gill nets. In 1869, pound nets were first used in the Albemarle Sound and became a more prominent aspect of the fishery in the early 1900s (Taylor and White 1992). The commercial fishery for striped bass has principally occurred from November through April in the Albemarle Sound, whereas, Roanoke River commercial effort was concentrated during the spring spawning run. During the summer months, landings from all areas were much lower (Hassler et al. 1981). Anchored and drift gill nets were the most productive gear types in the spring spawning run portion of the Roanoke River fishery. In 1981, anchored gill nets were prohibited in the Roanoke River, and the mesh size of drift gill nets was restricted, resulting in sharply curtailed landings during the spawning run (Hassler and Taylor 1984). Bow and dip netting was a productive method of harvesting spawning fish in the Roanoke River until it was prohibited in 1981. Prior to this rule, fishermen using bow nets in the upper Roanoke River could retain 25 striped bass per day when taken incidentally during shad and river herring fishing. A local law allowing the commercial sale of striped bass in Halifax and Northampton counties was enacted by the North Carolina General Assembly and created a prominent commercial fishery for striped bass in its principal spawning area (Hassler et al. 1981). This law was repealed in 1981 and commercial fishing for striped bass was eliminated in the inland portions of the Roanoke River. Limited commercial fishing seasons were implemented in Albemarle Sound in 1984 (October–May; Henry et al. 1992). State regulations enacted in 1985 prohibited the sale of hook-and-line-caught striped bass.

1.4.1.2 Current

The ASMA commercial striped bass fishery from 1990 through 1997 operated on a 44.45-metric ton (98,000-lb) TAL (Table 1.6). The TAL was split to have a spring and fall season. The commercial fishery operated with net yardage restrictions, mesh size restrictions, size limit restrictions, and daily landing limits. The A-R stock was declared recovered in 1997 by the ASMFC. In 1998, the commercial TAL was increased to 56.88 metric tons (125,400 lb) and additional increases in poundage occurred in 1999 and 2000. From 2000 through 2002, the commercial TAL remained at 102.1 metric tons (225,000 lb). In 2015, the TAL was adjusted to a total of 124.7 metric tons (275,000 lb) for all sectors, based on projections from the 2014 benchmark stock assessment (NCDMF 2014). Since the initial TAL was set in 1990, seasons, yardage, mesh size restrictions, and daily landing limits have been used to control harvest and maintain the fishery as a bycatch fishery.

1.4.2 Recreational Fishery

Striped bass are landed recreationally in the ASMA and RRMA by hook and line, primarily by trolling or casting artificial lures and using live or cut bait. In recent years, the catch-and-release

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fly fishery in the RRMA has seen an increase in angler effort. Combined recreational harvest from both management areas has ranged from 5.9 metric tons (13,095 lb) in 1985 to 106.9 metric tons (235,747 lb) in 2000 (Table 1.7). Since 1997, harvest steadily increased from 25.2 metric tons (55,653 lb) to 106.9 metric tons (235,747 lb) in 2000. Since 2000, harvest has shown an overall decline, except for a slight increase in 2011–2012 for the ASMA, 2012 for the RRMA, 2015 for the ASMA, and 2015–2016 for the RRMA. The harvest estimate for 2017 in the ASMA stands as the third lowest on record since 1982.

1.5 Fisheries Management

1.5.1 Management Authority

Fisheries management includes all activities associated with maintenance, improvement, and utilization of the fisheries resources of the coastal area, including research, development, regulation, enhancement, and enforcement.

North Carolina's existing fisheries management system for striped bass is adaptive, with rulemaking authority vested in the North Carolina Marine Fisheries Commission (NCMFC) and the North Carolina Wildlife Resources Commission (NCWRC) within their respective jurisdictions. The NCMFC also has the authority to delegate to the fisheries director the ability to issue public notices, called proclamations, suspending or implementing particular commission rules that may be affected by variable conditions.

Fisheries management includes all activities associated with maintenance, improvement, and utilization of the fisheries resources of the coastal area, including research, development, regulation, enhancement, and enforcement. North Carolina's existing fisheries management system is powerful and flexible, with rulemaking (and proclamation) authority vested in the NCMFC and the NCWRC within their respective jurisdictions.

The North Carolina Department of Environmental Quality (NCDEQ) is the parent agency of the NCMFC and the NCDMF. The NCMFC is responsible for managing, protecting, preserving and enhancing the marine and estuarine resources under its jurisdiction, which include all state coastal fishing waters extending to three miles offshore. In support of these responsibilities, the NCDMF conducts management, enforcement, research, monitoring statistics, and licensing programs to provide information on which to base these decisions. The NCDMF presents information to the NCMFC and NCDEQ in the form of fisheries management and coastal habitat protections plans and proposed rules. The NCDMF also administers and enforces the NCMFC's adopted rules.

The NCWRC is a state government agency authorized by the General Assembly to conserve and sustain the state's fish and wildlife resources through research, scientific management, wise use and public input. The Commission is the regulatory agency responsible for the creation and enforcement of hunting, trapping and boating laws statewide and fishing laws within its jurisdictional boundaries including all designated inland fishing waters. The NCWRC and NCDMF share authority for regulating recreational fishing activity in joint fishing waters.

1.5.2 Management Unit Definition

There are two geographic management units defined in the estuarine striped bass FMP and include the fisheries throughout the coastal systems of North Carolina (NCDMF 2004). The management unit for this assessment is the ASMA and RRMA and is defined as:

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Albemarle Sound Management Area (ASMA) includes the Albemarle Sound and all its joint and inland water tributaries, (except for the Roanoke, Middle, Eastmost and Cashie rivers), Currituck, Roanoke and Croatan sounds and all their joint and inland water tributaries, including Oregon Inlet, north of a line from Roanoke Marshes Point across to the north point of Eagle Nest Bay in Dare county. The Roanoke River Management Area (RRMA) includes the Roanoke River and its joint and inland water tributaries, including Middle, Eastmost and Cashie rivers, up to the Roanoke Rapids Dam. The striped bass stock in these two harvest management areas is referred to as the Albemarle Sound-Roanoke River (A-R) stock, and its spawning grounds are located in the Roanoke River in the vicinity of Weldon, NC. Management of recreational and commercial striped bass regulations within the ASMA is the responsibility of the North Carolina Marine Fisheries Commission (NCMFC). Within the RRMA commercial regulations are the responsibility of the NCMFC while recreational regulations are the responsibility of the North Carolina Wildlife Resources Commission (NCWRC). The A-R stock is also included in the management unit of the Atlantic States Marine Fisheries Commission (ASMFC) Amendment #6 to the Interstate Fishery Management plan (FMP) for Atlantic Striped Bass and includes Albemarle Sound and all its joint and Inland Water tributaries, (except for the Roanoke, Middle, Eastmost and Cashie rivers), Currituck, Roanoke, and Croatan sounds and all their Joint and Inland Water tributaries, including Oregon Inlet, north of a line from Roanoke Marshes Point 35 48'.5015' N – 75 44'.1228' W across to the north point of Eagle Nest Bay 35 44'.1710' N - 75 31'.0520' W (Figure 1.1).

1.5.3 Regulatory History

The ASMA commercial striped bass fishery from 1991 through 1997 operated on a 44.45-metric ton TAL (Table 1.6). The TAL was split to have a spring and fall season. The commercial fishery operated with net yardage restrictions, mesh size restrictions, size limit restrictions, and daily landing limits. The A-R stock was declared recovered in 1997 by the ASMFC. In 1998, the commercial TAL was increased to 56.88 metric tons and additional increases in the TAL occurred in 1999 and 2000. From 2000 through 2002, the commercial TAL remained at 102.1 metric tons. The ASMFC Striped Bass Management Board approved another TAL increase in 2003. From 2003 to 2014, the TAL remained at 249.5 metric tons. Based on a stock assessment benchmark, the TAL was reduced to 124.7 metric tons in 2015. Since the initial TAL was set in 1990, seasons, yardage, mesh size restrictions, and daily landing limits have been used to control harvest and maintain the fishery as a bycatch fishery.

Striped bass have been managed as a bycatch of the multi-species commercial fishery in the ASMA since 1991. Since 1991, when the striped bass season was open, commercial fishermen were allowed to land from seven to 15 fish per day, not to exceed 50% by weight of the total catch and fish had to meet the 18-inch TL minimum size limit. Gill nets continue to account for the highest percentage of the commercial harvest, followed by pound nets.

1.5.4 Current Regulations

Striped bass from the A-R stock are harvested commercially within the ASMA and recreationally in both the RRMA and the ASMA. Commercial harvest is currently limited to the ASMA although there was a small commercial fishery operating in the Roanoke River during the early 1980s. The commercial fishery is regulated as a bycatch fishery with a TAL, size limits, daily possession limits, seasonal (closed May 1 through September 30) and gear restrictions, net attendance requirements, and permitting and reporting requirements all imposed to prevent TAL overages and limit discard losses. Finfish dealers who purchase striped bass are required to obtain a striped bass dealer permit from NCDMF. The dealers are required to report their landings daily to NCDMF for the quota to be monitored. Dealers are also required to affix striped bass sale tags, provided by NCDMF, to the fish when purchased from the fishermen.

The recreational fishery within the RRMA is regulated through a creel limit, minimum size limit including a protective slot, and a fixed length spring season, while the ASMA recreational fishery is regulated through a creel limit, minimum size, and the variable spring and fall seasons that close once harvest targets are reached or set season closure dates are reached (closed May 1 through September 30). The A-R striped bass stock is managed by the NCDMF, the NCWRC, and the South Atlantic Fisheries Coordination Office (SAFCO) of the U.S. Fish and Wildlife Service (USFWS) under guidelines established in the ASMFC Interstate FMP for Atlantic Striped Bass and the North Carolina Estuarine Striped Bass FMP.

1.5.5 Management Performance

Management strategies for the A-R striped bass stock have met with variable success over the last several decades. Unrestricted harvest and poor habitat conditions led to a stock collapse in the 1980s; however, severe harvest restrictions and Roanoke River streamflow improvements led to population recovery spurred by increases in recruitment, spawning stock biomass growth, and age structure expansion in the late 1990s and 2000s. Consequently, commercial and recreational harvest restrictions were eased, and the TAL was increased throughout the 2000s. From 1990 through 2002, harvest reached the TAL easily, with the season often having to close after only weeks or months to prevent harvest from exceeding the TAL. Starting in 2003, with the increase in TAL to 249 metric tons, harvest started to consistently decline through 2008, even with extended commercial and recreational seasons in the ASMA. From 2009 through 2014, harvest was still well below the TAL (Figure 1.7). The reason for the decline in harvest even with extended seasons is likely due to declining stock abundance due to several poor year classes produced from 2001 to present. Even with a reduction in the TAL in 2015 to 125 metric tons, harvest has not reached the TAL, although a reduced American shad season starting in 2014 could have contributed to the commercial quota not being reached as the majority of commercial harvest historically came during the American shad commercial season in the ASMA. Recent survey data and stock assessments have supported managers' concerns about declining landings, poor recruitment, reductions in population abundance, and a truncation of age structure (NCDMF 2014, 2018).

1.6 Assessment History

1.6.1 Review of Previous Methods & Results

The A-R stock has an extensive assessment history. Dorazio (1995) and Gibson (1995) prepared the first comprehensive assessment of the A-R striped bass stock based on a Virtual Population Analysis (VPA using CAGEAN, Deriso et al. 1985) and a Brownie tag-return model analysis (Brownie et al. 1985). Schaaf (1997) later provided CAGEAN-based VPA results through 1996 based on the methodology established in Gibson (1995). Smith (1996) used the MARK software program to estimate survival of striped bass in Albemarle Sound through analysis of release and recovery data. Carmichael (1998) updated the CAGEAN assessment through 1997 and later developed an ADAPT VPA assessment of the A-R stock using age-specific indices from the Albemarle Sound Independent Gill-Net surveys, the Roanoke River Electrofishing Survey, and

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juvenile and yearling abundance indices from Albemarle Sound (Carmichael 1999). The 1999 assessment also included an analysis of tag-return data based on the MARK program. The ADAPT catch-at-age and MARK tag-return assessment framework was updated in 2000 (Carmichael 2000). Analysis of tag-return data for estimation of mortality was discontinued after 2000 as the results were deemed similar to those from the VPA and was duplicative work; subsequent assessments focused on the catch-at-age data. The VPA stock assessment was conducted annually until 2006 to determine stock status and to evaluate potential changes to the TAL (Carmichael 2001, 2002, 2003; Grist 2004, 2005; Takade 2006). The assessment shifted to an ASAP2 model for the 2010 assessment and a yield-per-recruit (YPR) model was used to calculate the benchmarks externally (Takade 2010). The 2014 assessment was performed similarly using an ASAP3 model and benchmarks were calculated with a YPR model. Projections were made using the Age Structured Projection Model (AGEPRO). The most recent stock assessments indicated that the stock was not overfished and overfishing was not occurring (Mroch and Godwin 2014; Flowers et al. 2016).

1.6.2 Progress on Research Recommendations

- Incorporate high reward tagging into the current tagging program to provide estimates of tag return rates for each sector; this will allow for more precise estimates of natural mortality and fishing mortality from tag-based analyses.

  There is an ongoing multi-species tagging study that was initiated in 2014 and funded through the NCDMF Coastal Recreational Fishing Fund. The study employs both high reward and double tags to estimate tag loss and angler reporting rates.

- Improve estimates of discard losses from the Albemarle Sound Management Area (ASMA) commercial gill-net fisheries.

  NCDMF’s Programs 466 and 467 monitor commercial gill-net fisheries and record bycatch (see also section 2.1.2). These programs are continually expanding and should lead to improved estimates of commercial discards over time.

- Re-evaluate hook-and-release mortality rates from the ASMA and RRMA recreational fisheries incorporating different hook types and angling methods at various water temperatures (e.g., live bait, artificial bait, and fly fishing).

  No progress.

- Improve estimates of hook-and-release discard losses in the recreational fishery during the closed harvest season

  There is a plan in place starting in May 2021 to provide additional funding to the existing striped bass creel survey in the ASMA that will extend intercepts during the closed harvest season (May–September).

2 DATA

2.1 Fisheries-Dependent

2.1.1 Commercial Landings

2.1.1.1 Survey Design & Methods

Prior to 1978, North Carolina's commercial landings data were collected by the National Marine Fisheries Service (NMFS). Between 1978 and 1993, landings information was gathered through the NMFS/North Carolina Cooperative Statistics program. Reporting was voluntary during this period, with North Carolina and NMFS port agents sampling the state's major dealers (Lupton and Phalen 1996). Beginning in 1994, the NCDMF instituted a mandatory dealer-based trip-ticket system to track commercial landings.

On January 1, 1994, the NCDMF initiated a Trip Ticket Program (NCTTP) to obtain more complete and accurate trip-level commercial landings statistics (Lupton and Phalen 1996). Trip ticket forms are used by state-licensed fish dealers to document all transfers of fish sold from coastal fishing waters from the fishermen to the dealer. The data reported on these forms include transaction date, area fished, gear used, and landed species as well as fishermen and dealer information.

The majority of trips reported to the NCTTP only record one gear per trip; however, as many as three gears can be reported on a trip ticket and are entered by the program's data clerks in no particular order. When multiple gears are listed on a trip ticket, the first gear may not be the gear used to catch a specific species if multiple species were listed on the same ticket but caught with different gears. In 2004, electronic reporting of trip tickets became available to commercial dealers and made it possible to associate a specific gear for each species reported. This increased the likelihood of documenting the correct relationship between gear and species.

2.1.1.2 Sampling Intensity

North Carolina dealers are required to record the transaction at the time of the transactions and report trip-level data to the NCDMF on a monthly basis. For further information on the sampling methodology for the NCTTP, see NCDMF 2019.

2.1.1.3 Biological Sampling

Biological sampling occurs during the spring and fall fishery. NCDMF personnel have a target of 600 samples from the spring fishery and 300 samples from the fall fishery. Fish are sampled monthly from various fish houses throughout the ASMA, throughout each season. Fish are measured to the nearest mm for fork length (FL) and TL and weighed to the nearest 0.01 kg. Sex is determined using the Sykes (1957) method and scales are removed from the left side of the fish, above the lateral line and between the posterior of the first dorsal fin and the insertion of the second dorsal fin. Scales are cleaned and pressed on acetate sheets using a Carver heated hydraulic press. NCDMF employees read scales using a microfiche reader set on 24x or 33x magnification. For each sex, a minimum of 15 scales per 25-mm size class is read and subsequently used to assign ages to the remainder of the sample.

2.1.1.4 Potential Biases & Uncertainties

All fish that are caught are not required to be landed (discards) or sold so some fish may be taken home for personal consumption and are not reported in the landings. The reporting of multiple

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gears on a single trip ticket could also be a source of bias since the order in which gears are reported are not indicative of the primary method of capture.

2.1.1.5 Development of Estimates

Commercial landings were summarized by year using the NCTTP data. Length data collected from the commercial fish house sampling program were used to compute annual length-frequency distributions by sex.

2.1.1.6 Estimates of Commercial Landings Statistics

The NCTTP is considered a census of North Carolina commercial landings, though reliability of the data decreases as one moves back in time. Commercial landings were highest in the late 1960s and have substantially decreased through recent years (Figure 2.1). Landings have been constrained with a TAL since 1991.

The minimum lengths and ages observed in the commercial fisheries landings are strongly tied to the minimum length regulations at the time fish are collected, measured, and aged. The most noticeable impact is the implementation of the 18-inch minimum TL length limit in 1991; striped bass less than 45 cm TL (~18 inches; Figures 2.2, 2.3) and younger than age 3 (Figures 2.4, 2.5) have been rarely observed since 1991. The length and age compositions show that fewer larger and older fish have been observed in recent years (Figures 2.2–2.5).

2.1.2 Commercial Gill-Net Discards

2.1.2.1 Survey Design & Methods

NCDMF's Program 466 (Onboard Observer Monitoring) was designed to monitor fisheries for protected species interactions in the gill-net fishery by providing onboard observations. Additionally, this program monitors finfish bycatch and characterizes effort in the fishery. The onboard observer program requires the observer to ride onboard the commercial fishermen's vessel and record detailed gill-net catch, bycatch, and discard information for all species encountered. Observers contact licensed commercial gill-net fishermen holding an Estuarine Gill-Net Permit (EGNP) throughout the state to coordinate observed fishing trips. Observers may also observe fishing trips from NCDMF vessels under Program 467 (Alternative Platform Observer Program), but these data were not used in this stock assessment due to the lack of biological data collected through the program.

2.1.2.2 Sampling Intensity

Fishing trips targeting striped bass are observed throughout the year; however, most observed trips occur during the fall when landings are the greatest in the Albemarle and the spring for the Pamlico Sound, both areas of which have a history of Atlantic sturgeon and sea turtle interactions.

2.1.2.3 Biological Sampling

Data recorded includes species, weight, length, and fate (landed, live discard, or dead discard).

2.1.2.4 Potential Biases & Uncertainties

Program 466 began sampling statewide in May 2010. To provide optimal coverage throughout the state, management units were created to maintain proper coverage of the fisheries. Management units were delineated based on four primary factors: (1) similarity of fisheries and management, (2) extent of known protected species interactions in commercial gill-net fisheries, (3) unit size, and (4) the ability of the NCDMF to monitor fishing effort. Total effort for each management unit

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can vary annually based on fishery closures due to protected species interactions or other regulatory actions. Therefore, the number of trips and effort sampled each year by management unit varies both spatially and temporally.

Program 466 data do not span the entire time series for the assessment (no data are available for 1991–2000) and statewide sampling began in May 2010 decreasing the variability of observed trips with better spatial and temporal sampling beginning in 2012.

Striped bass discard data were not available in sufficient quantities to estimate discards or post-release mortality from commercial pound net or gig fisheries; however, these fisheries and others are known to have discards of striped bass. Additionally, commercial discards likely occur in other states, so the estimates presented here likely underestimate the total number of striped bass commercial discards removed from the A-R stock.

It is also important to note that this survey was designed to target trips that occur in times and areas where protected species interactions are highest; the program does not target striped bass trips. For this reason, a high number of zero-catch trips relative to striped bass occur in the data.

2.1.2.5 Development of Estimates

A generalized linear model (GLM) framework was used to predict striped bass discards in the A-R gill-net fishery based on data collected during 2012 through 2017. Only those variables available in all data sources were considered as potential covariates in the model. Available variables were year, season, mesh category (small: <5 inches and large: ≥5 inches) and management area (Figure 2.6), which were all treated as categorical variables in the model. Effort was measured as soak time (days) multiplied by net length (yards). Live and dead discards were modeled separately.

All available covariates were included in the initial model and assessed for significance using the appropriate statistical test. Non-significant covariates were removed using backwards selection to find the best-fitting predictive model. The offset term was included in the model to account for differences in fishing effort among observations (Zuur et al. 2009, 2012). Using effort as an offset term in the model assumes the number of striped bass discards is proportional to fishing effort (A. Zuur, Highland Statistics Ltd., personal communication).

Examination of the data indicated they were significantly zero inflated for both the live and dead discards. There are two types of models commonly used for count data that contain excess zeros. Those models are zero-altered (two-part or hurdle models) and zero-inflated (mixture) models (see Minami et al. 2007 and Zuur et al. 2009 for detailed information regarding the differences of these models). Minami et al. (2007) suggests that zero-inflated models may be more appropriate for catches of rarely encountered species; therefore, zero-inflated models were initially considered though were unable to converge. For this reason, zero-altered models were pursued.

The best-fitting model for live discards and for dead discards was applied to available effort data from the NCTTP to estimate the total number of live discards and dead discards for the A-R gill-net fishery.

In order to develop estimates of commercial discards for years prior to 2012, a hindcasting approach was used. The ratio of live or dead discards in numbers to A-R gill-net landings was computed by year for 2012 to 2017. As these ratios were variable among years (Figure 2.7), the working group decided to apply the median ratio over 2012 to 2017 separately for live and dead discards. The median ratio for either live or dead discards was multiplied by the commercial gill-

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net landings in 1991 to 2011 to estimate the live and dead commercial gill-net discards for those years.

Because only dead discards were input into the assessment model, the estimates of live commercial gill-net discards were multiplied by 43%, an estimate of post-release mortality described in section 1.2.6.2. These estimates of live discards that did not survive were added to the estimates of commercial dead discards to produce an estimate of total dead discards for the commercial gill-net fishery for 2012 to 2017.

The available length samples from the NCDMF's Program 466 were summarized by year and used to characterize the length distribution of striped bass commercial discards by year.

2.1.2.6 Estimates of Commercial Gill-Net Discard Statistics

The best-fitting GLM for the commercial gill-net live discards assumed a zero-altered Poisson distribution (dispersion=2.9). The significant covariates for both the count and binary part of the model were year, season, mesh, and area. The best-fitting GLM for the dead discards assumed a zero-altered Poisson (dispersion=2.7). The significant covariates for the count part of the model were year, season, mesh, and area and the significant covariates for the binary part of the model were season and mesh.

Estimates of annual commercial dead discards ranged from a low of 2,500 striped bass in 2008 to a high of just over 11,600 striped bass in 2001 between 1991 and 2017 (Table 2.1; Figure 2.8). Total lengths of commercial discards have ranged from 10 cm to 85 cm (Figure 2.9). The majority of discards have been less than 60 cm TL.

2.1.3 Albemarle Sound Recreational Fishery Monitoring

From the 1950s through the late 1980s, various researchers conducted creel surveys in the Albemarle Sound and Roanoke River, although the Roanoke River has the most complete historical time series of catch and effort data (Hassler et al. 1981). Starting in 1988 and 1990 respectively, the NCWRC and NCDMF initiated annual creel surveys in the RRMA and ASMA that have continued to date.

2.1.3.1 Survey Design & Methods

The NCDMF collects catch and effort data through on-site interviews at boat ramps during allowed harvest days for each of four ASMA sampling zones (Figure 2.10). Statistics were calculated through a non-uniform probability access-point creel survey (Pollock et al. 1994). Site probabilities were set in proportion to the likely use of a site according to time of day, day of week, and season. Probabilities for this survey were assigned based on seasonal striped bass fishing pressure observed during past surveys, in addition to anecdotal information (S. Winslow and K. Rawls, NCDMF, personal communication). Probabilities can be 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 one and a half hours after sunrise until one hour after sunset. These values varied among sites within zones due to differing fishing pressure.

2.1.3.2 Sampling Intensity

The ASMA striped bass creel survey data series includes estimates of effort, catch, and discards for years 1990–2017. The survey does not operate during the closed harvest season, so estimates of catch and release during this time are not available. In the early years of the survey when the

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TAL was very low, the seasons may have only lasted a few days to a few weeks. In recent years as the TAL has increased, the harvest season occurs from October 1 through April 30. Creel clerks work all three weekend days (Friday–Sunday) and two weekdays. Interview sessions are approximately five hours and 45 minutes long, either in the morning or afternoon.

2.1.3.3 Biological Sampling

In the ASMA creel survey, all striped bass are sampled during the surveys and measured for TL (mm) and weighed to the nearest 0.1 kg by NCDMF personnel. No scales are collected for ageing purposes. Striped bass are not sexed during the creel survey.

2.1.3.4 Potential Biases & Uncertainties

One bias that has increased over time in the ASMA creel survey is the number of private access sites that are not included in the pool of public access points available to the survey. The increase in private sites is due to increased development of single-family dwellings and developments on the Albemarle Sound and tributaries in the last 20 years.

Another bias inherent in any non-uniform probability access-point creel survey is accurately matching the site probabilities to actual fishing pressure throughout the harvest season. Determining accurate probabilities is made more difficult when the harvest area is a large, open system such as a coastal estuary, and the species of interest is migratory in nature and movement (and hence fishing pressure) varies throughout the harvest area seasonally.

The bias associated with the increase in the number of private access points not included in the survey serves to systematically underestimate harvest and effort statistics, while the bias associated with varying probabilities throughout the season is not systematic and can produce under or over estimates of harvest and effort on an annual basis.

2.1.3.5 Development of Estimates

In the ASMA from 1990 to the spring season of 2005, a non-uniform probability roving access-point creel survey was used to estimate recreational hook-and-line effort and catch and release of striped bass during the allowed harvest seasons. Catch and effort data are collected daily for each of four ASMA sampling zones. Fishing effort was estimated by counting empty boat trailers at public and private boating access sites and using interview data to remove trailer counts for other users, including recreational fishermen targeting other species, hunters, recreational boaters, and commercial fishermen. Harvest was estimated as the product of catch rates and total fishing effort stratified by day and zone (Pollock et al. 1994).

In the ASMA from the fall of 2005 to present, angler catch statistics were calculated through a non-uniform probability access-point creel survey (Pollock et al. 1994). Site probabilities were set in proportion to the likely use of a site according to time of day, day of week, and season. Probabilities for this survey were assigned based on seasonal striped bass fishing pressure observed during past surveys, in addition to anecdotal information (S. Winslow and K. Rawls, NCDMF, personal communication). Probabilities can be 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 one and a half hours after sunrise until one hour after sunset. These values varied among sites within zones due to differing fishing pressure. Harvest was estimated by applying the sample unit probabilities to interview data stratified by day and zone (Pollock et al. 1994).

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Dead discards (no live) were input into the assessment model, so the estimates of Albemarle Sound recreational discards were multiplied by 6.4%, an estimate of post-release mortality described in section 1.2.6.2.

Lengths sampled from the Albemarle Sound recreational creel survey were used to characterize the length distribution of striped bass harvested by the Albemarle Sound recreational fishery by year.

In the absence of length samples from the recreational fisheries characterizing the releases, tagging data of striped bass recaptured by recreational anglers was used to develop length frequencies for the recreational releases. The composition of the total catch was derived first and then the length composition of the harvested fish was subtracted to estimate the length composition of the recreational releases. Due to the very low numbers of recaptured fish in some years, the recaptured fish length data were pooled across all years. For recaptures without lengths associated with them, if they were caught within three months of initial release, negligible growth was assumed and they were assigned a recapture length equal to the initial tagging length. The number of recaptures with associated lengths per year for the Albemarle Sound ranged from 3 to 127 with a mean of 39. Effective sample size was determined as the average number of unique locations and dates per year for recaptures in the associated management area. The proportion of fish recaptured per 2-cm length bin, t_l, was calculated from these pooled data such that:

$$t_l = \frac{\sum_{y=1997}^{y=2017} T_{y,l}}{\sum_{y=1997}^{y=2017} T_y}$$

where $T_{y,l}$ is the number of fish tagged in year y and length bin l. A smoother was applied across the resulting proportion data using the following centrally-weighted five-point moving average:

$$Smoothed[t_l] = \frac{[t_{l-2} + t_{l-1} + 3t_l + 2t_{l+1} + t_{l+2}]}{9}$$

The length composition of the total catch per year and length bin, $C_{y,l}$, was then estimated as:

$$Smoothed\left[C_{y,l}\right] = Smoothed[t_l]C_y$$

where C_y is the total catch numbers of striped bass per year.

A smoother was applied to recreational harvest length frequencies, $H_{y,l}$, and the numbers of recreational releases per year and length bin, $D_{y,l}$, were then estimated as:

$$D_{y,l} = Smoothed\left[C_{y,l}\right] - [H_{y,l}]$$

In some instances, this produced length bins with negative discard values. The negative values were truncated to zero, and the data set for each year was then rescaled to match the original total number of releases per year.

2.1.3.6 Estimates of Albemarle Sound Recreational Fishery Statistics

Annual recreational harvest of striped bass in the Albemarle Sound has ranged from a low of 3,500 fish in 2010 to a high of just over 40,000 fish in 2001 (Table 2.2; Figure 2.11). No overall trend is apparent in the recreational harvest time series, but estimates in the most recent two years (2016 and 2017) are among the lowest observed since 1991.

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Estimates of recreational dead discards in the Albemarle Sound have been variable from 1991 through 2017 (Table 2.2; Figure 2.12). Recreational dead discards have ranged from a low of 605 striped bass in 2006 to a high of over 5,800 striped bass in 1998.

The length distribution of recreational harvested striped bass has remained relatively consistent from 1996 through 2017 (Figure 2.13). The majority of lengths fall between 45 and 60 cm TL. Lengths of striped bass observed in the Albemarle Sound recreational discards have also demonstrated consistency over the years in which lengths are available (1997–2017; Figure 2.14); the majority of these recreational discards range between 40 and 60 cm TL.

2.1.4 Roanoke River Recreational Fishery Monitoring

2.1.4.1 Survey Design & Methods

The NCWRC conducts the RRMA striped bass creel survey to estimate angler effort, catch, and harvest during the spring harvest season. In some years, estimates of angler effort and catch and release of striped bass after the harvest season closes are also made (depending on available funding). The creel survey employs a non-uniform probability, stratified access-point creel survey design (Pollock et al. 1994) to estimate recreational fishing effort (angler hours, and angler trips), harvest of striped bass, and numbers of striped bass caught and released. The creel survey is stratified by area (upper zone or lower zone), time (AM or PM), and type of day (weekdays and weekend days). The upper zone includes the river segment from Roanoke Rapids Lake dam downstream to the U.S. Highway 258 Bridge near Scotland Neck (Figure 2.15). The lower zone extends from U.S. Highway 258 Bridge downstream to Albemarle Sound. Because past analyses depict differential catch rates through progression of the open harvest season, the survey was stratified into two-week sample periods. Within periods, samples and estimates are further stratified by type of day because fishing effort and catch is also known to vary as a function of day type. Selection of access points where interviews occurred was based on probability of boat trailer counts generated from prior RRMA creel surveys as well as expert opinion by biological and enforcement staff. Probabilities of fishing activity for time of day (0.4 for AM and 0.6 for PM during periods one and two and equal probabilities during all other periods) are estimated based upon prior experience with the RRMA striped bass fishery.

2.1.4.2 Sampling Intensity

The RRMA striped bass creel survey data series includes 1988–2017 for harvest season estimates and 1995–1999, 2005–2008, and 2010–2017 for closed season catch and effort estimates. The creel survey is conducted during March, April, and May of each year. Creel clerks typically work two weekdays and both weekend days each week. Interview sessions last three hours and one session is conducted in each zone each sample day.

2.1.4.3 Biological Sampling

RRMA striped bass creel clerks record the total number of striped bass caught and the number of striped bass harvested. Creel clerks measure TL (mm), weight (kg), and determine sex of each striped bass harvested when possible. Counts and total weights of harvested striped bass (i.e., no individual data) are recorded for angling parties when interview sessions are busy. In some years, creel clerks also record the number of striped bass released within length limit categories (e.g., short, legal, slot, over-slot), type of bait used, angler residency, and trip expenditures.

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2.1.4.4 Potential Biases & Uncertainties

In the RRMA creel survey, sample unit probabilities are adjusted each year depending on current conditions and expected trends in angler effort. Additionally, construction of new boating access areas has necessitated addition and deletion of creel locations. The NCWRC Jamesville-Astoria Rd. boating access area was added to the survey in 2011, and the two private ramps in Jamesville were subsequently removed from the survey. In 2016, a new boating access area in Lewiston-Woodville was added to the survey. Calculation of fishing effort was made using expansions of trailer count data from 1988–2001, but from 2002–2017, fishing effort was calculated by expanding interview data by the sample unit probability.

2.1.4.5 Development of Estimates

From 1988–2001, total fishing effort was estimated from counts of empty boat trailers at boating access areas along the entire river. Trailer counts were conducted each day of the open season. Total numbers of anglers were estimated by expanding trailer counts by the mean number of anglers per party as determined from interviews at access areas. The starting point for effort counts was randomly selected. Counts were made during mid-morning, or mid-afternoon periods. Based on interview data, trailer counts were adjusted to eliminate commercial fishermen, hunters, and recreational boaters. Data were adjusted based on the proportion of recreational anglers interviewed by creel clerks within each zone by period and kind of day. Harvest was estimated as the product of catch rates and total fishing effort stratified by period, zone, and kind of day (weekday or weekend day).

From 2002–2017, a specifically designed creel survey program was used to provide estimates of catch, harvest, and effort using formulas derived from Pollock et al. (1994). Estimates of striped bass catch, harvest, and effort for each sample day were made by expanding interview data by the sample unit probability (product of the access point probability and time of day probability). Within sample periods, catch, harvest, and effort estimates for weekdays and weekend days are separately averaged. The averages are then expanded to the total number of days of each type for that sample period. Separate estimates of total catch, harvest, and effort are made for each zone. Finally, sample period and zone totals are added to calculate the annual estimates.

Only dead discards were input into the assessment model, so the estimates of Roanoke River recreational discards were multiplied by 6.4%, an estimate of post-release mortality described in section 1.2.6.2.

As discard estimates were only available starting in 1995, a hindcasting approach was used to develop estimates back to 1991. The ratio of dead discards to harvest in numbers was calculated for 1995 through 2017 (Figure 2.16). The median ratio over those years was multiplied by the Roanoke River recreational harvest in 1991 to 1994 to estimate the dead discards for these earlier years.

Lengths sampled from the Roanoke River recreational creel survey were used to characterize the length distribution of striped bass harvested by the Roanoke River recreational fishery by year.

Roanoke River discard length compositions were derived using the same methodology as the Albemarle Sound discard length compositions described in section 2.1.3.5. The number of recaptures with associated lengths per year for the Roanoke River ranged from 18 to 191 with a mean of 88.

2.1.4.6 Estimates of Roanoke River Recreational Fishery Statistics

Estimates of recreational harvest in the Roanoke River have ranged from a low of about 3,100 fish in 1985 to a high of just over 38,000 fish in 2000 (Table 2.3; Figure 2.17). Recreational harvest increased from the beginning of the time series in 1982 to the early 2000s. Since then, recreational harvest in the Roanoke River has shown an overall slight decline.

Discards from the Roanoke River recreational fishery have been variable (Table 2.3; Figure 2.18). Estimates have ranged from a low of 4,215 striped bass in 2017 to a high of over 18,600 striped bass in 1997. There is no clearly discernable trend in these discard estimates over time.

As was observed with the Albemarle Sound recreational harvest and discard lengths, there was consistency in the total lengths observed in the Roanoke River recreational harvest (Figure 2.19) and discards (Figure 2.20) observed over time. The majority of striped bass collected from the Roanoke River recreational fishery were between 40 cm and 55 cm TL for both the harvest and discards.

2.2 Fisheries-Independent

2.2.1 Juvenile Abundance Survey (Program 100)

2.2.1.1 Survey Design & Methods

The NCDMF Juvenile Anadromous Survey, also known as Program 100 (P100), targets young-of-year (YOY) striped bass using a bottom trawl in Albemarle Sound. The survey was taken over by the NCDMF in 1984 and continues to sample the same seven fixed stations in western Albemarle Sound initiated in 1955 by Dr. William Hassler of N.C. State University, making it one of the longest continuous time series of striped bass fisheries-independent abundance data on the east coast (Figure 2.21). The sampled habitats are preferred nursery habitat for YOY striped bass in the Albemarle Sound as they increase in size and move from near-shore nursery areas to more open water habitats (Hassler et. al 1981).

The survey uses an 18-foot semi-balloon trawl with a body mesh size of 0.75-inch bar mesh and a 0.125-inch bar mesh tail bag. Tow duration is 15 minutes. Temperature, salinity, and dissolved oxygen are recorded.

2.2.1.2 Sampling Intensity

Trawl sampling is conducted bi-weekly for eight weeks starting in mid-July at seven established locations in the western Albemarle Sound area for a total of 56 samples. Trawl sites are located at the edge of breaks and contours, usually within the 2.4 m–3.7 m (8 feet–12 feet) depth profile.

2.2.1.3 Biological Sampling

All striped bass captured are counted and a subsample (maximum of 30) is measured (mm; TL and FL). In the event a striped bass is captured that may overlap with the size range of a YOY and a 1-year old striped bass, the specimen is brought back to the lab for examination of otoliths and/or scale samples to determine its age. In recent years, a subsample of YOY and age-1 striped bass has been weighed to the nearest gram for improved length at age relationships.

2.2.1.4 Potential Biases & Uncertainties

The Juvenile Abundance Survey is a fixed survey that the division appropriated from another source, so the fixed stations were retained for the continuity of data. A fixed-station survey can run the risk of bias if the sites selected do not adequately represent the sampling frame.

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Additionally, even if the sites adequately cover the sampling frame, the increased variation that would come about from sampling randomly is not accounted for and is therefore at risk of being neglected.

Indices derived from fixed-station surveys such as P100 may not accurately reflect changes in population abundance (Warren 1994, 1995). The accuracy of the estimates is tied to the degree of spatial persistence in catch data of the species (Lee and Rock 2018). The persistence of the P100 data were evaluated following the approach of Lee and Rock (2018) and results suggested a lack of year*station interaction, which indicates the presence of spatial persistence and so suggests the survey is likely tracking trends in relative abundance.

2.2.1.5 Development of Estimates

A nominal index was calculated by year using a standard arithmetic mean (numbers per tow). A generalized linear model (GLM) framework was also used to model the relative abundance of YOY striped bass. Potential covariates were evaluated for collinearity by calculating variance inflation factors. Collinearity exists when there is correlation between covariates and its presence causes inflated p-values. The Poisson distribution is commonly used for modeling count data; however, the Poisson distribution assumes equidispersion; that is, the variance is equal to the mean. Count data are more often characterized by a variance larger than the mean, known as overdispersion. Some causes of overdispersion include missing covariates, missing interactions, outliers, modeling non-linear effects as linear, ignoring hierarchical data structure, ignoring temporal or spatial correlation, excessive number of zeros, and noisy data (Zuur et al. 2009, 2012). A less common situation is underdispersion in which the variance is less than the mean. Underdispersion may be due to the model fitting several outliers too well or inclusion of too many covariates or interactions (Zuur et al. 2009).

Data were first fit with a standard Poisson GLM and the degree of dispersion was then evaluated. If over- or underdispersion was detected, an attempt was made to identify and eliminate the cause of the over- or underdispersion (to the extent allowed by the data) before considering alternative models, as suggested by Zuur et al. (2012). For example, the negative binomial distribution allows for overdispersion relative to the Poisson distribution whereas a quasi-Poisson GLM can be used to correct the standard errors for overdispersion. If the overdispersion is the result of an excessive number of zeros (more than expected for a Poisson or negative binomial), then a model designed to account for these excess zeros can be applied. There are two types of models that are commonly used for count data that contain excess zeros: zero-altered (two-part or hurdle models) and zero-inflated (mixture) models (see Minami et al. 2007 and Zuur et al. 2009 for detailed information regarding the differences of these models). Minami et al. (2007) suggests that zero-inflated models may be more appropriate for catches of rarely encountered species; therefore, zero-inflated models were considered here when appropriate.

All available covariates were included in the initial model and assessed for significance using the appropriate statistical test. Non-significant covariates were removed using backwards selection to find the best-fitting predictive model.

2.2.1.6 Estimates of Survey Statistics

Available covariates were year, depth, surface and bottom temperature, and surface and bottom salinity. The best-fitting GLM model assumed a negative binomial distribution (dispersion=1.4) and the significant covariates were year and bottom temperature.

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The nominal and GLM-standardized indices were similar throughout the time series (Figure 2.22). Both exhibit substantial inter-annual variability over time.

2.2.2 Independent Gill-Net Survey

2.2.2.1 Survey Design & Methods

In October 1990, the NCDMF initiated the Striped Bass Independent Gill-Net Survey, also known as Program 135 (P135). The survey was designed to monitor the striped bass population in the Albemarle and Croatan sounds.

The survey follows a random stratified design, stratified by geographic area. This survey divides the water bodies comprising the Albemarle region into six sample zones that are further subdivided into one-mile square quadrants with an average of 22 quadrants per zone (Figure 2.23). Albemarle Sound, Croatan Sound, and Alligator River sample zones (Zones 2–7) were selected for this survey, based on previous sampling and historical abundance information (Street and Johnson 1977). Sampling in Zone 1 was discontinued shortly after the survey began in favor of sampling Zone 7, to allow for tagging to produce estimates of mixing of the Albemarle-Roanoke striped bass stock and the migratory portion of the Atlantic migratory stock which may utilize the eastern portion of the Albemarle Sound during the winter months while overwintering. The survey gear is a multi-mesh monofilament gill net. Four gangs of twelve meshes (2.5-, 3.0-, 3.5-, 4.0-, 4.5-, 5.0-, 5.5-, 6.0-, 6.5-, 7.0-, 8.0-, 10.0-inch stretched mesh, ISM) of gill nets are set in each quadrant by the fishing crew. One two-gang set is weighted to fish at the bottom (sink net), and the other is floating unless the area is unsuitable for gill-net sampling (marked waterways and areas with excessive submerged obstructions). The use of 12 different mesh sizes allowed for the capture of fish age one and older. Alternate zones and quadrants are randomly selected if the primary selection cannot be fished. A fishing day is defined as the two crews fishing the described full complement of nets for that segment for one day. One unit of effort is defined as each 40-yard net fished for 24 hours.

The fishing year is divided into two segments: (1) fall/winter survey period, 1 November through 28 February; and (2) spring survey period, 1 March through late May. The sampling methods remain the same during each sampling season. Areas fished, sampling frequency, and sampling effort is altered seasonally.

For the fall/winter segment, two survey crews fish replicate 40-yard anchored, floating, and sinking monofilament gill nets from 2.5- to 4.0- ISM in one-half inch increments with a twine size of 0.33 mm (#104), 5.0- to 7.0-ISM with a twine size of 0.40 mm (#139), and 8.0-ISM and 10.0-ISM, with a twine size of 0.57 mm (#277). Heavier twine sizes in the larger mesh nets are intended to improve retention of larger, heavier fish. Gill nets were constructed with a hanging coefficient of 0.5. Gear soak time is 48 hours for each selected quadrant.

In the spring segment, gill-net effort is concentrated in western Albemarle Sound (Zone 2) near the mouth of the Roanoke River (Figure 2.23). The shift to Zone 2 was designed to increase the chance of intercepting mature striped bass congregated in this area during their migration to the Roanoke River spawning grounds. Effort is concentrated in this zone to determine differences in the size, age, and sex composition of the spring spawning migration relative to the fall/winter resident population. Zone 2 is sub-divided into southern and northern areas.

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2.2.2.2 Sampling Intensity

The NCDMF monitors the adult striped bass population in Albemarle Sound through spring (March–May) and fall (November–February). The fishing year is divided into two segments: (1) fall/winter survey period, 1 November through 28 February; and (2) spring survey period, 1 March through late May. All zones are sampled equally, except in the spring when effort is shifted to Zone 2. Each crew samples each of the six zones, providing 24 fishing days per month and a total of 96 fishing days for the season. A fishing day is defined as one crew, fishing the full complement of nets specified, for that segment for one day (24 hours).

The southern area, adjacent to the Roanoke River, received increased effort at a 2:1 ratio south to north, based on the historical seasonal abundance of mature striped bass (Harris et al. 1985). Quadrants sampled are randomly selected as previously noted. Fishing effort is conducted continuously, seven days a week weather permitting, until the end of late May.

2.2.2.3 Biological Sampling

All striped bass are counted and measured and healthy striped bass that survived entanglement are tagged with internal anchor tags and then measured to the nearest mm for FL and TL. Scales are removed from the left side of the fish, above the lateral line and between the posterior of the first dorsal fin and the insertion of the second dorsal fin. When possible, sex is determined by applying directional pressure to the abdomen towards the vent and observing the presence of milt or eggs.

For both the fall/winter and spring segment, fish that did not survive entanglement are processed at the NCDMF laboratory. Fish are measured to the nearest mm for FL and TL and weighed to the nearest 0.01 kg. Sex is determined by visual inspection and scales are removed as previously described. Scales are cleaned and pressed on acetate sheets using a Carver heated hydraulic press. Scales are read using a microfiche reader set on 24x or 33x magnification. For each sex, a minimum of 15 scales per 25 mm size class is read and subsequently used to assign ages to the remainder of the sample.

2.2.2.4 Potential Biases & Uncertainties

The P135 Survey deploys a passive gear of an array of nets with varying mesh size over a variety of randomly selected locations. The effort expended on survey design should result in estimates with relatively low bias. The survey design was informed by previous abundance and sampling data. It is possible that changes in the stock (habitat use, migration corridors, etc.) since the implementation of the sampling program may cause estimates to vary.

Many factors affect gill-net catch efficiency including net visibility and turbidity (Berst 1961; Hansson and Rudstam 1995), though setting nets overnight may offset some concerns of net visibility. Efficiency can also decrease if nets become tangled or fouled with debris. In the P135 Survey, performance of individual net panels is evaluated and recorded and catch is evaluated at the sample level (catch from a gang of nets is a sample), so performance of individual net panels may not have a large impact on catch from a sample.

2.2.2.5 Development of Estimates

Nominal indices of abundance were developed for both the fall/winter and spring components of the P135 Survey and were calculated using stratified average estimator (numbers per gang of net, 480 yards of 12 mesh sizes). For both the fall/winter and spring segments, only catches observed during the first 24 hours of the soak were included in the development of the index. Standardized indices were also calculated using the GLM approach described in section 2.2.1.5.

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Biological data collected during the survey were summarized to characterize both the length and age frequencies of striped bass observed by sex and survey component.

2.2.2.6 Estimates of Survey Statistics

Available covariates for the GLM standardization included year, quad (fall/winter only), depth, and surface temperature. The best-fitting GLM for the fall/winter index assumed a negative binomial distribution (dispersion=1.6) and the significant covariates were year, quad, and surface temperature. The best-fitting GLM for the spring index assumed a negative binomial distribution (dispersion=1.5) and the significant covariates were year, depth, and surface temperature.

The GLM-standardized indices tracked well with the nominal indices for both the fall/winter (Figure 2.24) and spring (Figure 2.25) components of the P135 Survey. Indices from both components of the survey indicate decreasing trends in the most recent years of the time series (Figures 2.24, 2.25).

Females observed during the fall/winter component of the P135 Survey have ranged from 15 cm to 95 cm TL and males have ranged from 15 cm to 80 cm TL (Figure 2.26). Striped bass observed during the spring component of this survey were generally larger; females have ranged from 20 cm to 115 cm TL and males have ranged from 15 cm to 90 cm TL (Figure 2.27).

Females ranging from ages 1 to 10 have been collected during the fall/winter component of the P135 Survey (Figure 2.28). Males collected during the fall/winter have ranged in age from 1 to 7. Older striped bass tend to be observed during the spring component of this survey (Figure 2.29). Female striped bass as old as 15 and males as old as 10 have been observed in the spring. The modal age has varied over time for both females and males in both the fall/winter and spring components of the P135 Survey.

2.2.3 Roanoke River Electrofishing Survey

2.2.3.1 Survey Design & Methods

The NCWRC Electrofishing Survey on the Roanoke River spawning grounds began in 1991 to meet the ASMFC FMP requirements to monitor spawning stock abundance (Figure 2.30). A boat-mounted electrofishing unit (Smith-Root 7.5 GPP) is used (1 dip netter) to capture fish during daylight hours. Sampling is conducted at stations within strata. Sampling stations are located on main and secondary river channel habitats. Three strata are sampled each day, and strata selection is dependent on flow conditions. Flows of approximately 7,000 cubic feet per second (cfs) or less restrict access to strata above the rapids in proximity to the Weldon boating access area. To minimize size selection during sampling, striped bass were netted as they were encountered regardless of size. Water temperature (°C) is recorded each sample day.

2.2.3.2 Sampling Intensity

NCWRC personnel collect striped bass weekly between mid-April and May, on the historic spawning grounds of the Roanoke River near Weldon (RM 130) and Roanoke Rapids (RM 137), North Carolina. Sampling begins as the water temperature approaches 15.0°C (59.0°F) and continues through the range of optimal spawning temperatures until water temperatures surpass 22°C or until striped bass spawning is complete; optimum spawning temperatures range from 18.0° to 22.0°C (64.4° to 71.6°F) for striped bass in the Roanoke River.

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2.2.3.3 Biological Sampling

Information on sex, age, and size composition of the spawning stock is also collected. Each fish is measured to the nearest mm for TL and sex is determined by assessing the presence of eggs or milt when pressure is applied to the fish's abdomen. Weight (kg) and scales are obtained from a subsample (target maximum of five fish of each 25-mm size group and sex per sample day) of fish. Weight and scales are collected from all fish greater than 700 mm. Scales are removed from the left side of the fish, above the lateral line and between the posterior of the first dorsal fin and the insertion of the second dorsal fin. Scales are aged using an EyeCom 3000 microfiche reader at 24x or 36x magnification. A primary reader ages up to 15 individuals per 25-mm length group per sex, and a subsample (20% of aged scales) is aged by a secondary reader for age verification. Age discrepancies between the readers are reconciled in concert.

2.2.3.4 Potential Biases & Uncertainties

The electrofishing survey spans a seven-mile section of the Roanoke River, determined to be the spatial extent of the spawning grounds. Site selection in early years of the survey was opportunistic to some degree, but multiple strata were always sampled so that sites were spread out within the spawning habitat/survey area each sample day. In more recent years, sites have been randomly selected within each of the three strata and the strata selections are based on flow conditions; however, some sample sites cannot be sampled due to flow conditions or angling activity. Inability to access sampling sites due to flow conditions or angler presence could bias the abundance estimates either by concentrating striped bass in the accessible areas or allowing striped bass to go undetected. Additionally, it is possible that fish may be missed by the dip netter. If striped bass are not universally available to the dip netter at all population densities, it could bias abundance estimates.

Other biases could be due to the gear itself; striped bass of abnormal size may not be as vulnerable to the stunning effects of the electrofishing gear and could escape capture. Electrofishing tends to select for larger fish as they are more visible to the dip netters and have a lower immobilization threshold (Sullivan 1956; Reynolds 1996; Dolan and Miranda 2003; Ruetz et al. 2007). For this reason, the relative abundance of smaller fish is likely biased too low (Reynolds 1996). Collection of fish by netting may be associated with bias. Daugherty and Sutton (2005) demonstrated that capture efficiency was affected by moderate flow rates due to movement of fish out of range of the netters. Schoenebeck and Hansen (2005) indicated how gear saturation caused electrofishing catch rate to be non-linearly related to abundance. Some fish may be less likely to be immobilized by electrofishing gear. Dolan and Miranda (2003) demonstrated how immobilization thresholds were inversely proportional to body size. Conductivity, water temperature, water transparency, dissolved oxygen, depth, flow, and electric current are some of the factors that can impact the efficiency of electrofishing gear (Reynolds 1996; McInerny and Cross 2000; Speas et al. 2004; Buckmeier and Schlechte 2009).

2.2.3.5 Development of Estimates

A nominal index was calculated using a ratio estimator (numbers per minute; Pollock et al. 1994). A standardized index was also calculated using the GLM approach described in section 2.2.1.5. An offset term was included in the model to account for differences in survey effort (measured in minutes) among sampling events (Zuur et al. 2009, 2012).

Biological data collected during the survey were summarized to characterize both the length and age frequencies of striped bass observed by sex.

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2.2.3.6 Estimates of Survey Statistics

Available covariates for the GLM were year, stratum, discharge, and temperature. The final best-fitting model assumed a negative binomial distribution (dispersion=1.3) and the significant covariates were year, stratum, and temperature. The nominal and GLM-standardized indices were similar throughout the time series (Figure 2.31). Both series exhibit inter-annual variation and both demonstrate a general declining trend since the early 2000s.

The total lengths of females observed in the Roanoke River Electrofishing Survey have ranged from 20 cm to 120 cm TL (Figure 2.32). Males have ranged in length from 10 cm to 110 cm TL. Some truncation of the length distributions is apparent in the most recent years of the survey.

A broad range of ages have been collected during this survey (Figure 2.33). Females have ranged in age from 1 to 17 years while males have ranged in age from 1 to 15 years. The age distributions have shown a truncation in the last few years of the survey.

3 ASSESSMENT

3.1 Method—Stock Synthesis

3.1.1 Scope

The unit stock was defined as all striped bass within the ASMA and RRMA.

3.1.2 Description

This assessment is based on a forward-projecting length-based, age-structured model. A two-sex model is assumed. The stock was modeled using Stock Synthesis (SS) text version 3.30.14 software (Methot 2000; Methot and Wetzel 2013; Methot et al. 2019). Stock Synthesis is an integrated statistical catch-at-age model that is widely used for stock assessments throughout the world. SS was also used to estimate reference point values. All input files are available upon request.

3.1.3 Dimensions

The assessment model was applied to data collected from within the range of the assumed biological stock unit (ASMA-RRMA; section 1.2.1).

The time period modeled was 1991 through 2017 using an annual time step based on the calendar year. The year 1991 was selected as the start year because it was the earliest year for which landings from the Albemarle Sound recreational fleet were available (section 2.1.3). The terminal year, 2017, was selected because it was the most recent year from which data were available at the start of the assessment process.

3.1.4 Structure / Configuration

3.1.4.1 Catch

The model initially incorporated three fishing fleets: ASMA commercial fishery (ARcomm), ASMA recreational fishery (ASrec), and the RRMA recreational fishery (RRrec). Landings (i.e., "retained" catch) were entered for each of these fleets (ARcomm: weight; ASrec: numbers; RRrec: numbers; Table 3.1; Figure 3.1). Dead discards (in numbers) were also included for each of the three fleets (Table 3.2; Figure 3.2). After evaluation of initial model runs, it was decided to treat the RRrec discards as a separate fleet (see section 3.1.4.8).

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3.1.4.2 Survey Indices

Four indices of relative abundance were selected for input into the model. All indices were derived from fisheries-independent surveys (Table 3.3; Figure 3.3). The index derived from the Program 100 Juvenile Trawl Survey (P100juv) was input as an index of age-0 recruitment and so associated biological data (lengths or ages) were not required as inputs into the model. Indices derived from the fall/winter component of the Program 135 Independent Gill-Net Survey (P135fw), the spring component of the Program 135 Independent Gill-Net Survey (P135spr), and the Roanoke River Electrofishing Survey (RRef) were also used.

Changes in indices over time can occur due to factors other than changes in abundance; the fisheries-independent indices were standardized using a GLM approach to attempt to remove the impact of some of these factors (Maunder and Punt 2004; see sections 2.2.1–2.2.3). Catchability (q) was assumed to be time-invariant for each survey and all survey indices were assumed to have a linear relation to abundance.

3.1.4.3 Length Composition

Annual length frequencies were input for each fleet's landings and discards for the years in which lengths were available for the particular fleet (see sections 2.1.1–2.1.3). Annual length frequencies characterizing the P135fw, P135spr, and RRef surveys were also input (see sections 2.2.2 and 2.2.3). Where possible, sex-specific length frequencies were used. Length frequencies were input by 2-cm length bins ranging from 10 cm to 130 cm TL.

3.1.4.4 Age Composition

Annual sex-specific age data were input for the AScomm landings as well as the P135fw, P135spr, and RRef surveys. The age data were input as raw age-at-length data, rather than age compositions generated from applying age-length keys to the catch-at-length compositions. The input compositions are therefore the distribution of ages obtained from samples in each length bin (conditional age-at-length). This approach is considered a superior approach because it avoids double use of fish for both age and length information, it contains more detailed information about the age-length relationship and so improves the estimation of growth parameters, and the approach can match the protocols of sampling programs where age data are collected in a length-stratified program (Methot et al. 2019).

Age 15 was treated as a plus group that included ages 15 through 17, the maximum age within the data input into the stock assessment model. Ages were assumed to be associated with small bias and negligible imprecision.

3.1.4.5 Biological Parameters

Natural Mortality

Natural mortality is one of the most important parameters in a stock assessment and one of the most difficult to estimate. The availability of an empirical estimate is rare. The empirical estimate of natural mortality from the Harris and Hightower (2017) study (0.72, see section 1.2.6.1) was assumed for both females and males in the model presented to the peer reviewers (see section 5) and treated as an age-invariant, fixed input. While the peer reviewers were pleased with the working group's attempt to incorporate an empirical estimate of natural mortality, they felt the value was too high given the species maximum age (see section 1.2.6.1).

Given the uncertainty in the assumed rate of natural mortality, a series of sensitivity runs were performed at the second peer review workshop in which the assumption regarding natural mortality

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was varied (see section 3.1.7.2). The values assumed for natural mortality in these runs were selected from the range estimated based on the species life history (Table 1.4; section 1.2.6.1). After discussion between the working group and the peer review panel, a value of 0.40 was settled on for use in the final base run. This value was assumed for both sexes and treated as an age-invariant, fixed input. Both the working group and the peer review panel felt this value was more appropriate given the species' life history and maximum age and was closer to the empirical estimate of natural mortality estimated in the Harris and Hightower (2017) study than other values explored.

Growth

Growth (age-length) was assumed to be sex specific and was modeled using the von Bertalanffy growth curve. In the SS model, when fish recruit at the real age of 0.0, their length is set equal to the lower edge of the first population length bin (here, 10 cm; Methot et al. 2019). Fish then grow linearly until they reach a real age equal to a user-specified age (here, age 1). As the fish continue to age, they grow according to the von Bertalanffy growth equation.

Allowing SS to estimate the growth curve ensures that the assumptions about selectivity are consistent with other parts of the model and that uncertainty in the growth estimates is incorporated into the estimates of spawning stock biomass, fishing mortality, and reference points (Hall 2013). All age-length growth parameters were estimated for both sexes. The estimated growth parameters for each sex were L_∞, K, coefficient of variation (CV) for length at age 1, and CV for L_∞. Initial values for L_∞ and K were derived by fitting the von Bertalanffy model to the available age-length data by sex (see also section 1.2.4; Table 1.1). Initial values for the CVs for length at age 1 and L_∞ were derived empirically for each sex. The initial values for the growth parameters were treated as informative priors (prior standard deviation=0.05 for L_∞ and K; prior standard deviation=0.8 for CV1 and CV2) assuming a normal distribution. Examination of the observed data was used to set reasonable bounds on all growth parameters for males and females.

Parameters of the length-weight relationship were fixed (i.e., not estimated) for both males and females. The assumed values were those estimated in this report as described in section 1.2.4 (Table 1.2).

Maturity & Reproduction

Female maturity at age as estimated by Boyd (2011; section 1.2.5.4) was treated as a fixed input in the model. Reproduction was assumed to occur on January 1 each year.

Fecundity

The selected fecundity option in SS was such that causes eggs to be equivalent to spawning biomass.

3.1.4.6 Stock-Recruitment

A Beverton-Holt stock-recruitment relationship was assumed. Virgin recruitment, R_0, was estimated within the model. Steepness, h, was fixed at 0.9 and the standard deviation of log(recruitment), σ_R, was fixed at 0.6. Recruitment deviations were estimated from 1980 to 2015. The deviations are assumed to sum to zero over this time period. Setting the first year in which to estimate recruitment deviations (1974) earlier than the model start year (1991) allows for a non-equilibrium age structure at the start of the assessment time series (Methot et al. 2019).

3.1.4.7 Fishing Mortality

SS allows several options for reporting fishing mortality (*F*). The *F* values reported here represent a real annual *F* calculated as a numbers-weighted *F* (see Methot et al. 2019) for ages 3–5. This age range was selected based on the high selectivity for this age range by the fleets and the large percentage of the total catch this age range comprises. Note the last NCDMF stock assessment for striped bass reported apical *F* values (*F* at age 4) and so are not directlycomparable to the results of this assessment (Flowers et al. 2016).

3.1.4.8 Selectivity

In SS, selectivity can be a function of length and/or age. In the current assessment, selectivity was assumed to be a function of length for all fleets and surveys due to the high confidence in the length data for characterizing these data sources. Retention for the fleets was also assumed to be a function of length (the only option for retention parameters).

In initial runs, all selectivity patterns were modeled using the recommended double normal curve. The double normal curve is extremely flexible and can take on shapes ranging from asymptotic to dome shaped. Evaluation of the initial model fits to the length composition data indicated some potential issues with the predicted selectivity patterns (i.e., strong patterns in the length residuals). Fits to the RRrec harvest lengths were especially poor so the decision was made to fix the selectivity to match the protective slot (section 1.5.4) and treat the discard portion of this fishery as a separate fleet. The presence of strong residual patterns in the fits to the length composition data prompted consideration of an even more flexible selectivity function, the cubic spline. Use of the cubic spline for the ARcomm fleet (six nodes) and the P135fw survey (three nodes) provided improvements in fits to the length composition data associated with these fleets and so was assumed in the final base model.

Early model runs suggested difficulty in predicting the female and male length composition data from the RRef survey. Investigation of the data and discussion with the model developer suggested this was due to the highly skewed sex ratio and different length frequency patterns between female and male striped bass observed in the survey. The SS model allows for selectivity for male fish to differ from selectivity for female fish and this option was selected for the RRef survey. The male selectivity parameters were modeled as an offset of the female selectivity parameters.

3.1.4.9 Equilibrium Catch

The SS model needs to assume an initial condition of the population dynamics for the period prior to the estimation period. Typically, two approaches are used to meet this assumption. The first approach starts the model as far back as necessary to satisfy the notion that the period prior to the estimation of dynamics was in an unfished or near unfished state. For striped bass, reliable catch records back to the start of the fishery are not available. For this reason, the model developer recommended use of the second approach, which is to estimate (where possible) initial conditions assuming equilibrium catch (R.D. Methot Jr., NOAA Fisheries, personal communication). The equilibrium catch is the catch taken from a fish stock when it is in equilibrium with removals and natural mortality balanced by stable recruitment and growth.

3.1.5 Optimization

The SS model assumes an error distribution for each data component and assigns a variance to each observation. The ARcomm landings, ASrec and RRrec harvests, and RRrec discards were fit in the model assuming a lognormal error structure. These data were assumed precise and assigned

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a minimal observation error. The standard errors (SEs) of the annual ARcomm landings were assumed equal to 0.02 prior to the start of the Trip Ticket program (1994; section 2.1.1) and were assumed equal to 0.01 for the remainder of the time series. As the commercial landings data are derived from a census and recreational data are derived from a survey, a slightly higher standard error was assumed for the annual ASrec and RRrec harvest estimates (SE=0.02). The RRrec discard estimates were based on a hindcast method in earlier years (1991–1994) of the time series and were assumed to have a CV equal to 0.06. Discard estimates from this fleet in subsequent years were assumed to have a CV equal to 0.04.

As dead discards are part of the overall total removals, they were also assumed to be precise, though were assumed to have higher variance than the landings and harvest due to the increased uncertainty in the estimation methods. The coefficient of variation (CV) assumed for the ARcomm discards was derived from the GLM standardization (see section 2.1.2.5). The CVs for discards from the ASrec fleet were derived empirically. A normal distribution was assumed for the error structure of the discards for each fleet.

Survey indices were fit assuming a lognormal error distribution with variance estimated from the GLM standardization.

Composition information was fit assuming a multinomial error structure with variance described by the effective sample size. For each fleet and survey, the effective sample size was the number of sampled trips and a maximum of 200 was imposed.

The objective function for the base model included likelihood contributions from the landings and harvest, discards, survey indices, length compositions, age data, and recruitment deviations. The total likelihood is the weighted sum of the individual components. All likelihood components with the exception of the age data, were initially assigned a lambda weight equal to 1.0. Based on a recommendation from the model developer, the likelihood components for the age data were reduced to 0.25 (R.D. Methot Jr., NOAA Fisheries, personal communication).

The model results are dependent, sometimes highly, on the weighting of each data set (Francis 2011). Francis (2011) points out that there is wide agreement on the importance of weighting, but there is lack of consensus as to how it should be addressed. In integrated models that use multiple data sets, it is not uncommon for the composition data to drive the estimation of absolute abundance when inappropriate data weightings are applied or the selectivity process is miss-specified (Lee et al. 2014). Francis (2011) argues that abundance information should primarily come from indices of abundance and not from composition data. Following the recommendation of Francis (2011), the model was weighted in two stages. Stage 1 weights were largely empirically derived (standard errors, CVs, and effective sample sizes described earlier in this section) and applied to individual data observations. Stage 2 weights were applied to reweight the length and age composition data by adjusting the input effective sample sizes. The stage 2 weights were estimated based on method TA1.8 (Appendix A in Francis 2011) using the SSMethod.TA1.8 function within the r4ss package (Taylor et al. 2019) in R (R Core Team 2019).

3.1.6 Diagnostics

Several approaches were used to assess model convergence. The first diagnostic was to check whether the Hessian matrix (i.e., matrix of second derivatives of the likelihood with respect to the parameters) inverted. Next, the model convergence level was compared to the convergence criteria (0.0001, common default value). Ideally, the model convergence level will be less than the criteria.

Model stability was further evaluated using a "jitter" analysis. This analysis is a built-in feature of SS in which the initial parameter values are varied by a user-specified fraction. This allows evaluation of varying input parameter values on model results to ensure the model has converged on a global solution. A model that is well behaved should converge on a global solution across a reasonable range of initial parameter estimates (Cass-Calay et al. 2014). Initial parameters were randomly jittered by 10% for a series of 50 random trials. The final model total likelihood value, annual estimates of spawning stock biomass (SSB), annual *F* values, and associated thresholds (see section 4) from the jitter runs were compared to the base run results.

Additional diagnostics included evaluation of fits to landings and harvest, discards, indices, and length compositions and comparison of predicted growth parameters to empirical values. The evaluation of fits to the various data components included a visual comparison of observed and predicted values and calculation of standardized residuals for the fits to the fisheries-independent survey indices and length composition data. The standardized residuals were first visually inspected to evaluate whether any obvious patterns were present. In a model that is fit well, there should be no apparent pattern in the standardized residuals. If most of the residuals are within one standard deviation of the observed value, there is evidence of under-dispersion. This is indicative of a good predictive model for the data. That is, the model is fitting the data much better than expected, given the assumed sample size.

Checking for patterns in standardized residuals over time can be done via the runs test, which was applied to the standardized residuals of the fits to the fisheries-independent survey indices. The runs test was applied using the RunsTest function in the DescTools package (Signorell et al. 2019) in R (R Core Team 2019). In a perfectly fit model, the standardized residuals have a normal distribution with mean equal to 0 and standard deviation equal to 1. The Shapiro-Wilk distribution test was applied to determine whether the standardized residuals of the fits to the fisheries-independent survey indices were normally distributed. This test was conducted using the shapiro.test function within the stats package in R (R Core Team 2019). An alpha level of 0.05 was used for both the runs test and Shapiro-Wilk distribution test to determine significance.

3.1.7 Uncertainty & Sensitivity Analyses

3.1.7.1 Evaluate Data Sources

Uncertainty can also be explored by assessing the contribution of each source of information (Methot 1990). The contribution of a data source or other parameter(s) can be manipulated by changing the weight, or emphasis, of the associated likelihood component.

The contribution of different fisheries-independent surveys was explored by removing the data from each survey one at a time in a series of model runs. In each of these runs, the survey under evaluation was effectively removed by assigning a lambda weight of 0.0 to the likelihood component for that survey's index and associated biological data (if present).

Annual estimates of female spawning stock biomass and *F* were compared to those from the base run.

3.1.7.2 Alternative Natural Mortality

Natural mortality was assumed to be constant across sexes and ages in the final base run (*M*=0.40; section 3.1.4.5); however, natural mortality that varies by sex and age may be more realistic. In one sensitivity run, natural mortality was assumed equal to the values derived using the modified Lorenzen approach described in section 1.2.6.1 (assumed sex-specific and age-variable).

Additionally, a run was performed in which natural mortality was assumed equal to the empirical estimate of 0.72 derived from the Harris and Hightower (2017) study (assumed sex- and age-constant). Finally, a run was performed in which natural mortality was assumed equal to 0.30 to provide a run that used a lower range value for natural mortality (assumed sex- and age-constant).

3.1.8 Results

A summary of the input data used in the base run of the striped bass stock assessment model is shown in Figure 3.4.

3.1.8.1 Base Run—Diagnostics

The final base run resulted in an inverted Hessian matrix, but the model's final convergence level was 0.00673183. This value is higher than the convergence criteria, which was set at 0.0001. It is not unusual for models with hundreds of parameters to produce higher convergence levels and so values less than 1.0 for such models are typically deemed acceptable (R.D. Methot Jr., NOAA Fisheries, personal communication). Four out of 111 estimated parameters were estimated near their bounds (Table 3.4). These are the CV for female age at L_∞, CV for male age at L_∞, initial equilibrium F for the RRrec discard fleet, and one of the selectivity parameters for the ARcomm fleet.

Twenty one of the 50 jitter runs successfully converged (Table 3.5). None of the converged jitter runs resulted in a likelihood value that was lower than the base run (Figure 3.5). The majority of the converged runs produced similar trends in female SSB and F to the base run (Figure 3.6). The results of one of the converged runs (run 46) was not included in these plots as it estimated female SSB to be an order of magnitude higher and F an order of magnitude lower than the other converged runs. Overall, the jitter analysis gives evidence that the base model converged to the global solution.

There is near identical agreement between observed and predicted landings and harvest for the ARcomm, ASrec, and RRrec fleets (Figure 3.7). This is not unexpected given the small amount of error assumed for these data (section 3.1.5). The SS model tended to underestimate discards for the ARcomm fleet (Figure 3.8A). For the ASrec discards, the model overestimated in some years and underestimated in others (Figure 3.8B). The RRrec discards were fit well by the model (Figure 3.8C).

Model fits to the fisheries-independent survey indices are reasonable (Figures 3.9–3.12). The model-predicted indices tended to capture the overall trend in the observed values for the P100juv (Figure 3.9), P135fw (Figure 3.10), and RRef (Figure 3.12) survey indices but did a poor job of predicting the trend for the P135spr survey index (Figure 3.11). The model did not capture the same degree of inter-annual variability seen in the observed index. Visual inspection of the standardized residuals indicates no clear temporal patterns for any of the survey indices and this was confirmed by the results of the runs tests, which produced non-significant (α=0.05) P-values (Table 3.6). None of the standardized residuals for the fisheries-independent survey indices were found to be significantly different from a normal distribution based on the results of the Shapiro-Wilk test for normality.

The fits to the length compositions aggregated across time appear reasonable for most of the fleets and surveys with the exception of the fit to the ARcomm discard lengths (Figure 3.13). This poor fit is likely due, in part, to the small effective sample sizes associated with the ARcomm discard length compositions. Examination of the fits to the length composition data by individual year

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indicates fits ranging from good to poor (Figures 3.14–3.28). Again, the poor fit to the ARcomm discard lengths is evident (Figure 3.16). The presence of bimodality in the P135fw survey lengths provided some difficulty in model fitting (Figures 3.23, 3.24). This was also true for the P135spr survey lengths (Figures 3.25, 3.26). Residuals from the fits to the length composition data for the different data sources are shown in Figures 3.29–3.37. The fits to the length composition data from the P135fw survey (Figures 3.35), P135spr survey (Figure 3.36), and RRef survey (Figure 3.37) show residual patterns which suggest the periodic presence of strong year classes. The strongest length composition residual patterns are evident in the ASrec harvest (Figure 3.31) and ASrec discard (Figure 3.32) fits. Fits to the ASrec harvest lengths suggest underestimation at mid-range lengths and overestimation at the smallest and largest lengths (Figure 3.31). The opposite pattern is seen in the fits to the ASrec discard lengths, which shows overestimation at mid-range lengths and underestimation at the smallest and largest lengths (Figure 3.32).

The growth curves estimated by the model are similar to the curves derived empirically (Figure 3.38). The predicted growth curves for both females and males suggest a small degree of underestimation of length at age.

3.1.8.2 Base Run—Selectivity & Population Estimates

The predicted selectivity curves are shown in Figures 3.39–3.41 and are considered reasonable.

Annual predicted recruitment is variable among years and demonstrates a general decrease over the time series (Table 3.7; Figure 3.42). Predicted recruitment deviations are shown in Figure 3.43 and show no obvious concerning pattern.

There is less inter-annual variability in predicted female spawning stock biomass (SSB; Table 3.7; Figure 3.44) than that exhibited in the predicted recruitment values (Figure 3.42). Female SSB values were highest in the late 1990s through the mid-2000s and have generally decreased since. The predicted stock-recruitment relationship indicates the relation is not particularly strong (Figure 3.45). This is not unexpected given the model assumed a fixed value of 0.9 for the steepness parameter. Predicted values of spawner potential ratio (SPR) show a slightly decreasing trend over the time series (Table 3.7; Figure 3.46).

Predicted population numbers at age suggest 60–65% of the population has been dominated by age-0 and age-1 fish (Tables 3.8–3.9). These predicted numbers at age show an increase in the numbers of older fish through the mid-2000s, followed by a possible truncation of age structure in recent years. The predictions of landings at age for the ARcomm fleet indicate that most (~82%) of the fish captured are ages 3 through 5 (Table 3.10). The majority (84%) of the discards for the ARcomm fleet are ages 2 through 5 (Table 3.11). The harvest for the ASrec fleet is dominated (nearly 81%) by ages 3 through 6 (Table 3.12). Approximately 74% of the discards for the ASrec fleet are ages 3 and 4 (Table 3.13). The RRrec fleet captures mostly (93%) age-3 to age-5 striped bass in the harvest (Table 3.14) while most (67%) of the RRrec discards are age 3 and 4 (Table 3.15).

Model predictions of annual F (numbers-weighted, ages 3–5) exhibit moderate inter-annual variability throughout the assessment time series and peaks are observed in 2012 and 2016 (Table 3.16; Figure 3.47). Predicted F values range from a low of 0.15 in 1997, 1999, and 2003 to a high of 1.3 in 2012. There a decline in F in the last year of the time series.

3.1.8.3 Evaluate Data Sources

The removal of the different survey data sets had minimal impact on estimates of female SSB and *F* (Figure 3.48).

3.1.8.4 Alternative Natural Mortality

Assuming age-varying natural mortality (Lorenzen *M*) and a lower value of natural mortality (*M*=0.30) produced estimates of female SSB that were lower than those in the base run while the overall trends were similar (Figure 3.49A). Using the higher empirically-derived value of natural mortality (*M*=0.72) resulted in higher estimates of female SSB than those predicted in the base run. The model that assumed the empirical estimate of natural mortality resulted in lower estimates of *F* relative to the base run as did the run that assumed natural mortality varied with age and sex (Figure 3.49B). Predicted *F* values were slightly higher when the lower value of natural mortality was assumed (*M*=0.30). estimates of recruitment increased by an order of magnitude when using the empirically-derived natural mortality and when using the Lorenzen natural mortality (Figure 3.50).

3.2 Discussion of Results

The current stock assessment for striped bass indicates some concerning trends. Observed recruitment in recent years of the assessment time series (Figures 2.22, 3.3A) has been relatively low and predicted recruitment has been showing a general decline recently (Figure 3.42). Overall, recruitment is highly variable and has been generally lower in recent years relative to that observed and predicted from 1991 through 2000. From 1993 through 2000, the stock produced seven of the top nine year classes in terms of age-0 abundance. The 2000 cohort is the largest produced in the entire time series. Since then, from 2001 through 2006, five out of the six cohorts produced were below-average in terms of numbers and only the 2005-year class is considered a strong year class (Table 3.7; Figure 3.42). These observations suggest there is another factor besides simply the size of SSB that has an influence on producing strong year classes. Much research from the 1950s through the 1980s supports the importance of flow in the Roanoke River during the spawning period and subsequent weeks while eggs and larvae are being transported down the Roanoke River to the nursery habitat in the western Albemarle Sound and the importance of flow in supporting abundant striped bass year-class production (Hassler et al. 1981; Rulifson and Manooch 1990; Zincone and Rulifson 1991).

The length (Figures 2.2, 2.3) and age (Figures 2.4, 2.5) compositions of striped bass sampled from the commercial landings show that fewer larger and older fish have been observed in recent years. A truncation of the length (Figure 2.32) and age (Figure 2.33) structure is also evident in the observations from the Roanoke River Electrofishing Survey. Recent observations from the Roanoke River Electrofishing Survey of abundance are the lowest in the time series (Figure 2.31). The abundance of age 9+ fish in the survey has also been declining in recent years. Predicted population numbers at age show a truncation in the most recent years of the time series and an overall decline in total population abundance (Tables 3.8, 3.9). Predicted female SSB (Figure 3.44) has also shown a declining trend in recent years and, estimates in recent years have been the lowest in the entire time series. The 2016 estimate of fishing mortality was the second highest in the time series and declined in 2017 (Figure 3.47).

Performance of the stock assessment model was considered good in terms of predicting the observed data. The quality of the fits is strongly tied to the input variance and effective sample sizes. Fits to the observed landings, harvest, and discard were reasonable and this was expected

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given the low variance assumed for these data sources. Of the fisheries-independent survey indices, all but the P135spr index were fit well and no issues were detected among the residuals for any of the survey indices. The model was insensitive to the removal of the various sources of fisheries-independent survey data suggesting the different surveys share similar signals in the data with regard to population trends.

Striped bass commonly migrate outside the bounds of the A-R management unit, either to other internal waters of North Carolina such as western Pamlico Sound and the Tar-Pamlico, Pungo, and Neuse rivers or by joining the migratory ocean stock. The probability of migration increases with age and has increased over time (Callihan et al. 2014). In the most recent years examined in Callihan et al. (2014), the probability has been most significant for fish age 6 and older (20% or greater). In addition, smaller adults show evidence of density-dependent movements and habitat utilization, as the likelihood of recapture outside the ASMA in adjacent systems increases during periods of higher stock abundance. When a striped bass migrates, it may not return to its natal waterbody; this could be due to harvest outside of the ASMA and RRMA and is not accounted for in the harvest losses here. This loss of fish from the system will likely be interpreted by the model as losses due to natural and/or fishing mortality. The most recent assessments of the A-R striped bass stocks attempted to account for these migration losses by adjusting the natural mortality rate by the probability of migration and fishing mortality occurring in the Atlantic Ocean, thereby creating an estimate of total unobserved mortality that accounted for both natural mortality and losses not attributable to North Carolina fisheries (Mroch and Godwin 2014; Flowers et al. 2016). In this assessment, migration losses were not specifically modeled; this total unobserved mortality was treated as fixed in the modeling process.

The ages in this assessment were derived from scales and were assumed to be associated with small bias and negligible imprecision; however, Welch et al. (1993) found that scales tend to underage striped bass for fish that are older than age ten. This suggests that the maximum age assumed for this assessment, age 17, may be an underestimate of the true maximum age. Assuming maximum age that is too young can positively bias the estimates of SPR (Goodyear 1993) and the derived reference points.

There is additional recent evidence that age 17 may not be the maximum age for the A-R stock. In 2017, an angler returned a striped bass tag from a fish that had been tagged on the spawning grounds in 2007, which was aged at the time to 13 years old, increasing the oldest know age fish in the A-R stock to 23. In April 2020, an angler caught and cut the tag off a striped bass in the Roanoke River that was originally tagged in 1995 and estimated to be age 6, which suggests the oldest known fish in the stock is now at 31 years old, likely from the 1989 year class. Note that these instances are of single tag returns and it is not known how reflective they are of the relative abundance of these older fish in the stock. The available observed data suggested few fish older than age 9 are present in the stock, especially in recent years.

4 STATUS DETERMINATION CRITERIA

The General Statutes of North Carolina define overfished as “the condition of a fishery that occurs when the spawning stock biomass of the fishery is below the level that is adequate for the recruitment class of a fishery to replace the spawning class of the fishery” (NCGS § 113-129). The General Statues define overfishing as “fishing that causes a level of mortality that prevents a fishery from producing a sustainable harvest.”

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The working group decided that the spawner potential ratio (SPR) was an appropriate proxy for developing reference points. Levels of SPR ranging from 20% to 50% have been found to be appropriate for various stocks, but historical analysis of SPR shows increased risk of recruitment overfishing levels if SPR falls below 30% (Walters and Martell 2004). For this assessment, threshold values were based on 35% SPR and targets were based on 45% SPR.

The fishing mortality reference points and the values of *F* that are compared to them represent numbers-weighted values for ages 3 to 5 (section 3.1.4.7). The SS model estimated a value of 0.13 for F_{Target} ($F_{45\%}$). The estimate of $F_{\text{Threshold}}$ ($F_{35\%}$) from the SS model was 0.18. The estimated value of fishing mortality in the terminal year (2017) of the model was 0.27, which is greater than the threshold value and suggests that overfishing is currently occurring in the stock ($F_{2017} > F_{\text{Threshold}}$; Figure 4.1).

The target level for female spawning stock biomass (SSB_{Target} or $SSB_{45\%}$) was estimated at 159 metric tons by the SS model. The estimated threshold for SSB ($SSB_{\text{Threshold}}$ or $SSB_{35\%}$) was 121 metric tons. Terminal year (2017) female SSB was 35.6 metric tons, which is less than the threshold value and suggests the stock is currently overfished ($SSB_{2017} < SSB_{\text{Threshold}}$; Figure 4.2).

The estimates in the most recent years are often associated with large uncertainty in stock assessment models. Approaching the ending year of the time series, the estimates of the most recent years lack data support from subsequent years during calibration. Nevertheless, stock status is often based on the terminal year estimates of fishing mortality and population size (or a proxy) to address the management needs and interests.

5 SUITABILITY FOR MANAGEMENT

Stocks assessments performed by the NCDMF in support of management plans are subject to an extensive review process, including a review by an external panel of experts. External reviews are designed to provide an independent peer review and are conducted by experts in stock assessment science and experts in the biology and ecology of the species. The goal of the external review is to ensure the results are based on the best science available and provide a valid basis for management.

The review workshop allows for discussion between the working group and review panel, enabling the reviewers to ask for and receive timely updates to the models as they evaluate the sensitivity of the results to different model assumptions. The workshop also allows the public to observe the peer review process and better understand the development of stock assessments.

The external peer review panel first met with the working group in person in December 2019. The reviewers were concerned with the external fit of the von Bertalanffy growth model to the observed age-length data; model predicted size was consistently smaller than empirical size for larger, older fish. The reviewers were also concerned with residual patterns in the fits to the length composition data indicative of model misspecification. Another major concern was failure of the model to capture trends observed in the empirical data. The peer reviewers did not support the presented model for management use but agreed to a second review after the working group addressed their concerns. In preparing the updated model, the working group noted an error in the input data that invalidated the first model. The working group corrected the data issue and also addressed the peer reviewer concerns regarding model fitting. A second assessment was presented to the peer review panel via webinar in June 2020.

The external peer reviewers worked with the working group to develop a model (presented in section 3) that the peer review endorsed for management use for at least the next five years and

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agreed the determination of stock status (overfished and overfishing) for the North Carolina Albemarle Sound-Roanoke River striped bass in the terminal year concurs with professional opinion and observations. The reviewers also agreed that: (1) the justification of inclusion and exclusion of data sources are appropriate; (2) the data sources used in this assessment are appropriate; (3) determination of stock status for the terminal year is robust to model assumptions on natural mortality and growth; (4) the extensive exploration of sensitivities to model assumptions and configurations, especially the sensitivity analysis regarding the natural mortality and growth assumptions, resolves the reviewers' primary areas of concerns such as the concerns over the fitting to growth data and length composition data and the concern regarding the overestimation of abundance for the last three years of the time series; (5) reviewers recommend future assessments consider key abiotic drivers of poor recruitment such as river flow and key biotic drivers such as catfish predation and competition; (6) reviewers also recommend collection of sex-specific growth data from juveniles and old fish to better inform growth estimates and length- or age-specific natural mortality estimates, and to resolve the concern on growth estimates showing little difference between males and females. Detailed comments from the external peer reviewers are provided in the Appendix.

While the peer reviewers did approve the model for management use and were confident in the declining trend in recruitment based on assessment results and results from the Juvenile Abundance Survey (P100; Figure 5.1), there was a great deal of uncertainty in the potential causes of the decline in recruitment (Appendix). One key uncertainty was related to the impacts of changes in river flow on YOY abundance. The review panel recognized the declining recruitment in the time series did not appear to result solely from reduced stock abundance due to harvest (i.e., overfishing). The review panel suggested future assessments consider formally incorporating the flow-recruitment relationship into the stock assessment as spring flow conditions are believed to influence recruitment and ultimately stock abundance. Another area of potential influence on the striped bass stock is the prevalence of the non-native blue catfish (*Ictalurus furcatus*). The population of blue catfish in the Roanoke River and western Albemarle Sound and tributaries has increased dramatically in recent years (Darsee et al. 2019; NCDMF 2019). The reviewers felt predation by blue catfishes could potentially impact recruitment of striped bass directly or could influence food resources for striped bass through competition for prey (e.g., Pine et al. 2005). The review panel recognized the degree to which this occurs is not known, but future assessments should consider this as a factor that may influence abundance but is not tied to striped bass harvest.

6 RESEARCH RECOMMENDATIONS

The research recommendations listed below are offered by the working group to improve future stock assessments of the A-R striped bass stock.

High

- Improve estimates of discard mortality rates and discard losses from the ASMA commercial gill-net fisheries (ongoing through observer program)
- Collect data to estimate catch-and-release discard losses in the ASMA recreational fishery during the closed harvest season
- Investigate relationship between river flow and striped bass recruitment for consideration of input into future stock assessment models

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Medium

- Transition to an assessment that is based on ages derived from otoliths
- Improve estimates of catch-and-release discard losses in the RRMA recreational fishery during the closed harvest season
- Incorporate tagging data directly into the statistical catch-at-age model
- Improve the collection of length and age data to characterize commercial and recreational discards
- Explore the direct input of empirical weight-at-age data into the stock assessment model in lieu of depending on the estimated growth relationships

Low

- Re-evaluate catch-and-release mortality rates from the ASMA and RRMA recreational fisheries incorporating different hook types and angling methods at various water temperatures (e.g., live bait, artificial bait, and fly fishing)
- Investigate the potential impact of blue catfish on the A-R striped bass population (e.g., habitat, predation, forage)

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8 TABLES

Table 1.1. Parameter estimates and associated standard errors (in parentheses) of the von Bertalanffy age-length growth curve by sex. The function was fit to total length in centimeters.

Sex	n	L_∞	K	t_0
Female	29,991	160 (0.81)	0.071 (0.00063)	-0.62 (0.014)
Male	29,691	161 (1.3)	0.064 (0.00082)	-0.87 (0.017)

Table 1.2. Parameter estimates and associated standard errors (in parentheses) of the length-weight function by sex. The function was fit to total length in centimeters and weight in kilograms.

Sex	n	*a*	*b*
Female	28,814	2.8E-06 (4.4E-08)	3.2 (2.3E-03)
Male	33,411	5.9E-06 (1.0E-07)	3.1 (2.7E-03)

Table 1.3. Percent maturity of female striped bass as estimated by Boyd (2011).

Age	% Maturity
0	0
1	0
2	0
3	28.6
4	96.8
5	100
6	100
7	100
8	100
9	100
10	100
11	100
12	100
13	100
14	100
15	100
16	100
17	100

Table 1.4. Age-constant estimates of natural mortality derived from life history characteristics.

Method	Female	Male	Average
Alverson and Carney 1975	0.37	0.44	0.40
Hoenig 1983 (regression)	0.26	0.30	0.28
Hoenig 1983 (rule-of-thumb)	0.25	0.28	0.26
Ralston 1987 (linear regression)	0.16	0.15	0.16
Jensen 1996 (theoretical)	0.11	0.095	0.10
Jensen 1996 (derived from Pauly 1980)	0.11	0.10	0.11
Cubillos 2003	0.099	0.090	0.094
Hewitt and Hoenig 2005	0.25	0.28	0.26
Hoenig (nls; from Then et al. 2015)	0.37	0.41	0.39
Then et al. 2015	0.30	0.34	0.32
Average	0.23	0.25	0.24

Table 1.5. Estimates of natural mortality at age by sex based on the method of Lorenzen (1996).

Age	Female	Male
0	2.8	2.2
1	1.4	1.3
2	1.0	1.0
3	0.88	0.88
4	0.79	0.80
5	0.73	0.74
6	0.69	0.70
7	0.66	0.67
8	0.64	0.65
9	0.62	0.63
10	0.60	0.62
11	0.59	0.60
12	0.58	0.59
13	0.57	0.58
14	0.56	0.57
15	0.56	0.57
16	0.55	0.56
17	0.55	0.56

Table 1.6. Changes in the total allowable landings (TAL) in metric tons and pounds (in parentheses) for the ASMA-RRMA, 1991–2017.

Regulatory Period	ASMA Commercial	ASMA Recreational	RRMA Recreational	Combined TAL
1991–1997	44.45 (98,000)	13.34 (29,400)	13.34 (29,400)	71.12 (156,800)
1998	56.88 (125,400)	28.44 (62,700)	28.44 (62,700)	113.8 (250,800)
1999	62.57 (137,940)	31.28 (68,970)	31.28 (68,970)	125.2 (275,968)
2000–2002	102.1 (225,000)	51.03 (112,500)	51.03 (112,500)	204.1 (450,000)
2003–2014	124.7 (275,000)	62.37 (137,500)	62.37 (137,500)	249.5 (550,000)
2015–2017	62.37 (137,500)	31.18 (68,750)	31.18 (68,750)	124.7 (275,000)

Table 1.7. Striped bass commercial landings and discards and recreational harvest and discards from the ASMA-RRMA, 1991–2017.

	Commercial Landings	Commercial Discards	Recreational Harvest		Recreational Discards	
	ASMA	ASMA	ASMA	RRMA	ASMA	RRMA
Year	metric tons	numbers	numbers	numbers	numbers	numbers
1991	49.24	10,267	14,395	26,934	1,507	9,516
1992	45.65	8,434	10,542	13,372	1,279	4,725
1993	49.70	8,952	11,404	14,325	847.4	5,061
1994	46.48	4,302	8,591	8,284		2,927
1995	39.88	4,938	7,343	7,471		3,373
1996	40.92	4,150	7,433	8,367		10,461
1997	43.64	3,967	6,901	9,364	1,969	18,673
1998	56.26	5,817	19,566	23,109	5,881	12,159
1999	73.94	7,401	16,967	22,479	2,581	10,468
2000	97.17	10,500	38,085	38,206	5,052	5,961
2001	100.0	11,630	40,127	35,231	3,931	4,544
2002	101.2	6,633	27,896	36,422	3,300	3,570
2003	120.9	10,394	15,124	11,157	1,618	2,448
2004	124.2	4,475	28,004	26,506	2,627	11,989
2005	105.6	9,566	17,954	34,122	1,358	10,093
2006	84.62	6,715	10,711	25,355	605.1	4,194
2007	77.94	4,803	7,143	19,305	870.3	3,360
2008	34.01	2,538	10,048	10,541	2,366	12,137
2009	43.49	3,294	12,069	23,248	2,596	8,702
2010	90.72	10,017	3,504	22,445	1,037	7,930
2011	61.86	6,646	13,341	22,102	1,381	6,894
2012	52.48	4,256	22,345	28,847	1,598	4,033
2013	31.03	6,706	4,299	7,718	1,048	4,750
2014	32.23	2,794	5,529	11,058	1,478	10,594
2015	51.98	3,539	23,240	20,031	3,170	6,927
2016	55.89	3,989	4,794	21,260	662.5	3,369
2017	34.50	2,762	4,215	9,899	1,578	5,021

Table 2.1. Annual estimates of commercial gill-net discards (numbers of fish), 1991–2017. Note that values prior to 2012 were estimated using a hindcasting approach.

Year	Discards
1991	10,267
1992	8,434
1993	8,952
1994	4,302
1995	4,938
1996	4,150
1997	3,967
1998	5,817
1999	7,401
2000	10,500
2001	11,630
2002	6,633
2003	10,394
2004	4,475
2005	9,566
2006	6,715
2007	4,803
2008	2,538
2009	3,294
2010	10,017
2011	6,646
2012	4,256
2013	6,706
2014	2,794
2015	3,539
2016	3,989
2017	2,762

Table 2.2. Annual estimates of recreational harvest and dead discards (numbers of fish) for the ASMA, 1991–2017.

Year	Harvest	Discards
1991	14,395	1,507
1992	10,542	1,279
1993	11,404	847
1994	8,591	
1995	7,343	
1996	7,433	
1997	6,901	1,969
1998	19,566	5,881
1999	16,967	2,581
2000	38,085	5,052
2001	40,127	3,931
2002	27,896	3,300
2003	15,124	1,618
2004	28,004	2,627
2005	17,954	1,358
2006	10,711	605
2007	7,143	870
2008	10,048	2,366
2009	12,069	2,596
2010	3,504	1,037
2011	13,341	1,381
2012	22,345	1,598
2013	4,299	1,048
2014	5,529	1,478
2015	23,240	3,170
2016	4,794	663
2017	4,215	1,578

Table 2.3. Annual estimates of recreational harvest and dead discards (numbers of fish) for the RRMA, 1991–2017. Note that discard values prior to 1995 were estimated using a hindcasting approach.

Year	Harvest	Discards
1991	26,934	9,516
1992	13,372	4,725
1993	14,325	5,061
1994	8,284	2,927
1995	7,471	3,373
1996	8,367	10,461
1997	9,364	18,673
1998	23,109	12,159
1999	22,479	10,468
2000	38,206	5,961
2001	35,231	4,544
2002	36,422	3,570
2003	11,157	2,448
2004	26,506	11,989
2005	34,122	10,093
2006	25,355	4,194
2007	19,305	3,360
2008	10,541	12,137
2009	23,248	8,702
2010	22,445	7,930
2011	22,102	6,894
2012	28,847	4,033
2013	7,718	4,750
2014	11,058	10,594
2015	20,031	6,927
2016	21,260	3,369
2017	4,215	5,021

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Table 3.1. Annual estimates of commercial landings and recreational harvest that were input into the SS model, 1991–2017. Values assumed for the coefficients of variation (CVs) are also provided.

Year	ASMA Commercial		ASMA Recreational		RRMA Recreational	
	metric tons	CV	numbers	CV	numbers	CV
1991	49.24	0.02	14,395	0.02	26,934	0.02
1992	45.65	0.02	10,542	0.02	13,372	0.02
1993	49.70	0.02	11,404	0.02	14,325	0.02
1994	46.48	0.01	8,591	0.02	8,284	0.02
1995	39.88	0.01	7,343	0.02	7,471	0.02
1996	40.92	0.01	7,433	0.02	8,367	0.02
1997	43.64	0.01	6,901	0.02	9,364	0.02
1998	56.26	0.01	19,566	0.02	23,109	0.02
1999	73.94	0.01	16,967	0.02	22,479	0.02
2000	97.17	0.01	38,085	0.02	38,206	0.02
2001	99.99	0.01	40,127	0.02	35,231	0.02
2002	101.18	0.01	27,896	0.02	36,422	0.02
2003	120.91	0.01	15,124	0.02	11,157	0.02
2004	124.20	0.01	28,004	0.02	26,506	0.02
2005	105.64	0.01	17,954	0.02	34,122	0.02
2006	84.62	0.01	10,711	0.02	25,355	0.02
2007	77.94	0.01	7,143	0.02	19,305	0.02
2008	34.01	0.01	10,048	0.02	10,541	0.02
2009	43.49	0.01	12,069	0.02	23,248	0.02
2010	90.72	0.01	3,504	0.02	22,445	0.02
2011	61.86	0.01	13,341	0.02	22,102	0.02
2012	52.48	0.01	22,345	0.02	28,847	0.02
2013	31.03	0.01	4,299	0.02	7,718	0.02
2014	32.23	0.01	5,529	0.02	11,058	0.02
2015	51.98	0.01	23,240	0.02	20,031	0.02
2016	55.89	0.01	4,794	0.02	21,260	0.02
2017	34.50	0.01	4,215	0.02	9,899	0.02

Table 3.2. Annual estimates of dead discards that were input into the SS model, 1991–2017. Values assumed for the coefficients of variation (CVs) are also provided.

Year	Albemarle/Roanoke Commercial		Albemarle Sound Recreational		Roanoke River Recreational	
	numbers	CV	numbers	CV	numbers	CV
1991	10,267	0.82	1,507	0.060	9,516	0.06
1992	8,434	0.67	1,279	0.051	4,725	0.06
1993	8,952	0.72	847	0.034	5,061	0.06
1994	4,302	0.34			2,927	0.06
1995	4,938	0.40			3,373	0.04
1996	4,150	0.33			10,461	0.04
1997	3,967	0.32	1,969	0.079	18,673	0.04
1998	5,817	0.47	5,881	0.24	12,159	0.04
1999	7,401	0.59	2,581	0.10	10,468	0.04
2000	10,500	0.84	5,052	0.20	5,961	0.04
2001	11,630	0.93	3,931	0.16	4,544	0.04
2002	6,633	0.53	3,300	0.13	3,570	0.04
2003	10,394	0.83	1,618	0.065	2,448	0.04
2004	4,475	0.36	2,627	0.11	11,989	0.04
2005	9,566	0.77	1,358	0.054	10,093	0.04
2006	6,715	0.54	605	0.024	4,194	0.04
2007	4,803	0.38	870	0.035	3,360	0.04
2008	2,538	0.20	2,366	0.095	12,137	0.04
2009	3,294	0.26	2,596	0.10	8,702	0.04
2010	10,017	0.80	1,037	0.041	7,930	0.04
2011	6,646	0.53	1,381	0.055	6,894	0.04
2012	4,256	0.17	1,598	0.064	4,033	0.04
2013	6,706	0.27	1,048	0.042	4,750	0.04
2014	2,794	0.11	1,478	0.059	10,594	0.04
2015	3,539	0.14	3,170	0.13	6,927	0.04
2016	3,989	0.16	663	0.027	3,369	0.04
2017	2,762	0.11	1,578	0.063	5,021	0.04

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Table 3.3. GLM-standardized indices of relative abundance derived from fisheries-independent surveys that were input into the SS model, 1991–2017. The empirically-derived standard errors (SEs) are also provided.

	Program 100 Juvenile		Program 135 Fall/Winter		Program 135 Spring		Roanoke River Electrofishing	
Year	**Index**	**SE**	**Index**	**SE**	**Index**	**SE**	**Index**	**SE**
1991	0.709	0.19	0.44	0.043				
1992	2.12	0.51	0.44	0.037	0.48	0.034		
1993	42.4	8.8	0.42	0.039	0.28	0.021		
1994	59.4	12	0.79	0.071	0.18	0.017	125	21
1995	8.54	1.8	0.31	0.024	0.94	0.063	42.1	7.0
1996	35.0	7.2	0.59	0.051	0.67	0.048	29.0	5.0
1997	5.12	1.1	0.54	0.031	0.84	0.057	75.7	12
1998	5.24	1.3	0.94	0.066	1.1	0.074	102	16
1999	0.968	0.26	0.49	0.034	1.1	0.069	92.1	15
2000	55.9	12	0.37	0.042	0.92	0.061	72.1	12
2001	3.52	0.82	0.50	0.053	1.1	0.072	210	35
2002	5.68	1.2	0.31	0.028	0.83	0.057	110	24
2003	0.253	0.095	0.80	0.060	0.38	0.029	221	39
2004	1.72	0.43	0.47	0.036	0.86	0.064	57.1	11
2005	23.0	4.8	0.65	0.057	0.71	0.051	104	17
2006	2.87	0.64	0.20	0.016	1.0	0.072	120	20
2007	4.94	1.1	0.83	0.085	0.41	0.031	53.0	8.8
2008	5.35	1.2	0.55	0.058	1.2	0.089	77.2	12
2009	0.363	0.11	0.54	0.048	0.71	0.057	76.5	13
2010	6.75	1.4	0.60	0.081	0.99	0.081	106	19
2011	15.3	3.2	0.20	0.018	1.1	0.094	46.3	7.7
2012	3.42	0.79	0.23	0.020	1.2	0.11	58.2	9.1
2013	0.369	0.11	0.37	0.032	1.4	0.12	39.6	7.6
2014	17.0	3.6	0.32	0.037	0.93	0.081	66.7	13
2015	18.4	3.8	0.17	0.017	0.51	0.039	46.4	9.1
2016	5.39	1.1	0.12	0.018	0.31	0.026	20.1	3.7
2017	1.29	0.30			0.36	0.030	14.5	2.5

Table 3.4. Parameter values, standard deviations (SD), phase of estimation, and status from the base run of the stock assessment model. LO or HI indicates parameter values estimated near their bounds.

ID	Label	Value	SD[Value]	Phase	Status
1	NatM_p_1_Fem_GP_1	0.40		-2	fixed
2	L_at_Amin_Fem_GP_1	17	0.050	3	estimated
3	L_at_Amax_Fem_GP_1	160	0.050	3	estimated
4	VonBert_K_Fem_GP_1	0.065	0.0010	3	estimated
5	CV_young_Fem_GP_1	0.19	0.0053	3	estimated
6	CV_old_Fem_GP_1	0.0010	8.4E-07	3	LO
7	Wtlen_1_Fem_GP_1	4.6E-06		-3	fixed
8	Wtlen_2_Fem_GP_1	3.2		-3	fixed
9	Mat50%_Fem_GP_1	1		-3	fixed
10	Mat_slope_Fem_GP_1	0		-3	fixed
11	Eggs/kg_inter_Fem_GP_1	1		-3	fixed
12	Eggs/kg_slope_wt_Fem_GP_1	0		-3	fixed
13	NatM_p_1_Mal_GP_1	0.40		-2	fixed
14	L_at_Amin_Mal_GP_1	18	0.050	4	estimated
15	L_at_Amax_Mal_GP_1	161	0.050	4	estimated
16	VonBert_K_Mal_GP_1	0.060	0.0011	4	estimated
17	CV_young_Mal_GP_1	0.19	0.0060	4	estimated
18	CV_old_Mal_GP_1	0.0010	8.0E-07	4	LO
19	Wtlen_1_Mal_GP_1	7.5E-06		-3	fixed
20	Wtlen_2_Mal_GP_1	3.1		-3	fixed
21	CohortGrowDev	1.0		-1	fixed
22	FracFemale_GP_1	0.50		-99	fixed
23	SR_LN(R0)	6.2	0.039	1	estimated
24	SR_BH_steep	0.90		-4	fixed
25	SR_sigmaR	0.60		-4	fixed
26	SR_regime	0		-4	fixed
27	SR_autocorr	0		-99	fixed
28	Main_InitAge_17	-0.37	0.52	4	estimated
29	Main_InitAge_16	-0.20	0.55	4	estimated
30	Main_InitAge_15	-0.23	0.55	4	estimated

Table 3.4. (*continued*) Parameter values, standard deviations (SD), phase of estimation, and status from the base run of the stock assessment model. LO or HI indicates parameter values estimated near their bounds.

ID	Label	Value	SD[Value]	Phase	Status
31	Main_InitAge_14	-0.30	0.53	4	estimated
32	Main_InitAge_13	-0.36	0.52	4	estimated
33	Main_InitAge_12	-0.38	0.50	4	estimated
34	Main_InitAge_11	-0.53	0.48	4	estimated
35	Main_InitAge_10	-0.75	0.45	4	estimated
36	Main_InitAge_9	-0.77	0.39	4	estimated
37	Main_InitAge_8	-0.76	0.34	4	estimated
38	Main_InitAge_7	-0.79	0.31	4	estimated
39	Main_InitAge_6	-0.88	0.30	4	estimated
40	Main_InitAge_5	-0.70	0.28	4	estimated
41	Main_InitAge_4	-0.23	0.22	4	estimated
42	Main_InitAge_3	0.65	0.091	4	estimated
43	Main_InitAge_2	0.037	0.11	4	estimated
44	Main_InitAge_1	-0.48	0.12	4	estimated
45	Main_RecrDev_1991	-0.54	0.12	4	estimated
46	Main_RecrDev_1992	-0.25	0.11	4	estimated
47	Main_RecrDev_1993	0.72	0.081	4	estimated
48	Main_RecrDev_1994	1.2	0.076	4	estimated
49	Main_RecrDev_1995	0.89	0.099	4	estimated
50	Main_RecrDev_1996	1.6	0.074	4	estimated
51	Main_RecrDev_1997	0.81	0.11	4	estimated
52	Main_RecrDev_1998	1.2	0.086	4	estimated
53	Main_RecrDev_1999	0.36	0.14	4	estimated
54	Main_RecrDev_2000	1.5	0.062	4	estimated
55	Main_RecrDev_2001	0.38	0.098	4	estimated
56	Main_RecrDev_2002	0.00039	0.085	4	estimated
57	Main_RecrDev_2003	-0.92	0.13	4	estimated
58	Main_RecrDev_2004	-0.12	0.088	4	estimated
59	Main_RecrDev_2005	0.81	0.077	4	estimated
60	Main_RecrDev_2006	0.47	0.098	4	estimated

Table 3.4. (*continued*) Parameter values, standard deviations (SD), phase of estimation, and status from the base run of the stock assessment model. LO or HI indicates parameter values estimated near their bounds.

ID	Label	Value	SD[Value]	Phase	Status
61	Main_RecrDev_2007	0.56	0.083	4	estimated
62	Main_RecrDev_2008	-0.24	0.082	4	estimated
63	Main_RecrDev_2009	-1.6	0.12	4	estimated
64	Main_RecrDev_2010	0.065	0.077	4	estimated
65	Main_RecrDev_2011	0.77	0.059	4	estimated
66	Main_RecrDev_2012	-0.0074	0.089	4	estimated
67	Main_RecrDev_2013	-0.91	0.16	4	estimated
68	Main_RecrDev_2014	0.43	0.095	4	estimated
69	Main_RecrDev_2015	0.39	0.11	4	estimated
70	Main_RecrDev_2016	0.020	0.13	4	estimated
71	Main_RecrDev_2017	-0.47	0.15	4	estimated
72	InitF_seas_1_flt_1ARcomm	0.085	0.0064	1	estimated
73	InitF_seas_1_flt_2ASrec	0.011	0.00055	1	estimated
74	InitF_seas_1_flt_3RRrecharv	0.019	0.00089	1	estimated
75	InitF_seas_1_flt_8RRecdisc	0.0057	0.00031	1	LO
76	LnQ_base_P100juv(4)	-8.2	0.56	5	estimated
77	Q_power_P100juv(4)	0.60	0.086	6	estimated
78	LnQ_base_P135fw(5)	-3.0	0.17	5	estimated
79	Q_power_P135fw(5)	-0.54	0.033	6	estimated
80	LnQ_base_P135spr(6)	-1.7	0.19	5	estimated
81	Q_power_P135spr(6)	-0.74	0.033	6	estimated
82	LnQ_base_RRef(7)	1.8	0.22	5	estimated
83	Q_power_RRef(7)	-0.37	0.056	6	estimated
84	SizeSpline_Code_ARcomm(1)	2.0		-99	fixed
85	SizeSpline_GradLo_ARcomm(1)	0.060	0.046	3	estimated
86	SizeSpline_GradHi_ARcomm(1)	0.0010	9.0E-05	3	HI
87	SizeSpline_Knot_1_ARcomm(1)	29		-99	fixed
88	SizeSpline_Knot_2_ARcomm(1)	45		-99	fixed
89	SizeSpline_Knot_3_ARcomm(1)	49		-99	fixed
90	SizeSpline_Knot_4_ARcomm(1)	52		-99	fixed

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Table 3.4. **(*continued*)** Parameter values, standard deviations (SD), phase of estimation, and status from the base run of the stock assessment model. LO or HI indicates parameter values estimated near their bounds.

ID	Label	Value	SD[Value]	Phase	Status
91	SizeSpline_Knot_5_ARcomm(1)	55		-99	fixed
92	SizeSpline_Knot_6_ARcomm(1)	88		-99	fixed
93	SizeSpline_Val_1_ARcomm(1)	-6.1	0.29	2	estimated
94	SizeSpline_Val_2_ARcomm(1)	-4.4	0.23	2	estimated
95	SizeSpline_Val_3_ARcomm(1)	-2.1	0.13	2	estimated
96	SizeSpline_Val_4_ARcomm(1)	-1.0		-99	fixed
97	SizeSpline_Val_5_ARcomm(1)	-1.1	0.072	2	estimated
98	SizeSpline_Val_6_ARcomm(1)	-2.6	0.30	2	estimated
99	Retain_L_infl_ARcomm(1)	30	3.6	1	estimated
100	Retain_L_width_ARcomm(1)	9.6	1.7	2	estimated
101	Retain_L_asymptote_logit_ARcomm(1)	999		-4	fixed
102	Retain_L_maleoffset_ARcomm(1)	0		-4	fixed
103	Size_DblN_peak_ASrec(2)	53	0.28	1	estimated
104	Size_DblN_top_logit_ASrec(2)	0.13	209	1	estimated
105	Size_DblN_ascend_se_ASrec(2)	3.7	0.057	2	estimated
106	Size_DblN_descend_se_ASrec(2)	3.5	123	2	estimated
107	Size_DblN_start_logit_ASrec(2)	-999		-4	fixed
108	Size_DblN_end_logit_ASrec(2)	15		-5	fixed
109	Retain_L_infl_ASrec(2)	40	0.38	1	estimated
110	Retain_L_width_ASrec(2)	5.1	0.19	2	estimated
111	Retain_L_asymptote_logit_ASrec(2)	999		-4	fixed
112	Retain_L_maleoffset_ASrec(2)	0		-4	fixed
113	Size_DblN_peak_RRrecharv(3)	46		-3	fixed
114	Size_DblN_top_logit_RRrecharv(3)	-2.2		-3	fixed
115	Size_DblN_ascend_se_RRrecharv(3)	-4.0		-4	fixed
116	Size_DblN_descend_se_RRrecharv(3)	-2.0		-4	fixed
117	Size_DblN_start_logit_RRrecharv(3)	-999		-4	fixed
118	Size_DblN_end_logit_RRrecharv(3)	-999		-5	fixed
119	SizeSpline_Code_P135fw(5)	2.0		-99	fixed
120	SizeSpline_GradLo_P135fw(5)	0.56	0.11	3	estimated

Table 3.4. (*continued*) Parameter values, standard deviations (SD), phase of estimation, and status from the base run of the stock assessment model. LO or HI indicates parameter values estimated near their bounds.

ID	Label	Value	SD[Value]	Phase	Status
121	SizeSpline_GradHi_P135fw(5)	-0.41	0.091	3	estimated
122	SizeSpline_Knot_1_P135fw(5)	25		-99	fixed
123	SizeSpline_Knot_2_P135fw(5)	42		-99	fixed
124	SizeSpline_Knot_3_P135fw(5)	57		-99	fixed
125	SizeSpline_Val_1_P135fw(5)	-4.6	0.38	2	estimated
126	SizeSpline_Val_2_P135fw(5)	-1.0		-99	fixed
127	SizeSpline_Val_3_P135fw(5)	-1.4	0.26	2	estimated
128	Size_DblN_peak_P135spr(6)	47	2.2	1	estimated
129	Size_DblN_top_logit_P135spr(6)	-0.018	222	1	estimated
130	Size_DblN_ascend_se_P135spr(6)	5.1	0.22	2	estimated
131	Size_DblN_descend_se_P135spr(6)	3.5	123	2	estimated
132	Size_DblN_start_logit_P135spr(6)	-999		-4	fixed
133	Size_DblN_end_logit_P135spr(6)	15		-5	fixed
134	Size_DblN_peak_RRef(7)	57	1.1	1	estimated
135	Size_DblN_top_logit_RRef(7)	0.014	219	1	estimated
136	Size_DblN_ascend_se_RRef(7)	4.4	0.099	2	estimated
137	Size_DblN_descend_se_RRef(7)	3.5	123	2	estimated
138	Size_DblN_start_logit_RRef(7)	-999		-4	fixed
139	Size_DblN_end_logit_RRef(7)	15		-5	fixed
140	SzSel_MaleDogleg_RRef(7)	59	1.8	1	estimated
141	SzSel_MaleatZero_RRef(7)	7.9	1.1	1	estimated
142	SzSel_MaleatDogleg_RRef(7)	0		-4	fixed
143	SzSel_MaleatMaxage_RRef(7)	-6.2	5.6	2	estimated
144	Size_DblN_peak_RRecdisc(8)	51	0.69	3	estimated
145	Size_DblN_top_logit_RRecdisc(8)	0.052	222	3	estimated
146	Size_DblN_ascend_se_RRecdisc(8)	4.4	0.095	4	estimated
147	Size_DblN_descend_se_RRecdisc(8)	3.5	123	4	estimated
148	Size_DblN_start_logit_RRecdisc(8)	-999		-4	fixed
149	Size_DblN_end_logit_RRecdisc(8)	15		-5	fixed

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Table 3.5. Results of the base run compared to the results of 50 jitter trials in which initial parameter values were jittered by 10%. A single asterisk (*) indicates that the Hessian matrix did not invert. Two asteriskes (**) indicate that the convergence level was greater than 1.

Run	Total LL	SSB_{2017}	$SSB_{Threshold}$	F_{2017}	$F_{Threshold}$
base	4,879	35.6	121	0.266	0.18
1	*				
2	**				
3	**				
4	*				
5	*				
6	*				
7	5,061	41.7	115	0.22	0.18
8	4,879	35.3	121	0.27	0.18
9	*				
10	4,956	35.5	115	0.26	0.18
11	*				
12	6,138	51.3	29.7	0.05	0.30
13	*				
14	4,879	35.3	121	0.27	0.18
15	4,879	35.6	121	0.27	0.18
16	4,879	35.6	121	0.27	0.18
17	5,298	45.5	40.2	0.07	0.20
18	**				
19	**				
20	4,879	35.6	121	0.27	0.18
21	*				
22	**				
23	4,879	35.3	121	0.27	0.18
24	*				
25	*				

Table 3.5. (*continued*) Results of the base run compared to the results of 50 jitter trials in which initial parameter values were jittered by 10%. A single asterisk (*) indicates that the Hessian matrix did not invert. Two asteriskes (**) indicate that the convergence level was greater than 1.

Run	Total LL	SSB_{2017}	$SSB_{Threshold}$	F_{2017}	$F_{Threshold}$
26	4,879	35.3	121	0.27	0.18
27	4,879	35.3	121	0.27	0.18
28	*				
29	4,886	35.6	122	0.27	0.19
30	*				
31	4,879	35.3	121	0.27	0.18
32	**				
33	**				
34	**				
35	4,879	35.3	121	0.27	0.18
36	*				
37	*				
38	7,009	50.4	42	0.087	0.19
39	4,956	35.5	115	0.26	0.18
40	**				
41	*				
42	*				
43	4,879	35.6	121	0.27	0.18
44	4,879	35.6	121	0.27	0.18
45	**				
46	7,390	1,667	739	0.026	0.27
47	*				
48	**				
49	*				
50	4,879	35.6	121	0.27	0.18

Table 3.6. Results of the runs test for temporal patterns and results of the Shapiro-Wilk test for normality applied to the standardized residuals of the fits to the fisheries-independent survey indices from the base run of the assessment model. *P*-values were considered significant at $\alpha = 0.05$.

	Runs Test		**Shapiro-Wilk**	
Survey	**median**	***P*-value**	**W**	***P*-value**
P100juv	-0.029	0.70	0.98	0.80
P135fw	0.016	1.0	0.98	0.81
P135spr	0.017	0.31	0.97	0.70
RRef	0.019	0.30	0.97	0.67

Table 3.7. Annual estimates of recruitment (thousands of fish), female spawning stock biomass (SSB; metric tons), and spawner potential ratio (SPR) and associated standard deviations (SDs) from the base run of the stock assessment model, 1991–2017.

Year	Recruitment		SSB		SPR	
	Value	SD	Value	SD	Value	SD
1991	227	27	148	10	0.22	0.012
1992	299	30	129	8.0	0.30	0.011
1993	780	57	116	7.0	0.26	0.011
1994	1,211	83	87	6.1	0.25	0.013
1995	876	82	67	4.9	0.23	0.011
1996	1,720	110	66	4.0	0.23	0.0096
1997	850	88	105	5.5	0.31	0.012
1998	1,284	98	165	8.2	0.31	0.012
1999	564	79	203	10	0.35	0.012
2000	1,736	87	266	12	0.29	0.010
2001	583	53	255	12	0.28	0.010
2002	398	31	243	11	0.28	0.010
2003	157	20	220	10	0.32	0.010
2004	356	29	259	8.1	0.27	0.0062
2005	889	60	209	5.7	0.24	0.0061
2006	618	57	140	4.2	0.20	0.0065
2007	643	46	81	3.3	0.14	0.0061
2008	277	20	60	3.1	0.21	0.0078
2009	75	9	94	4.6	0.24	0.0096
2010	404	28	108	4.6	0.22	0.0082
2011	810	40	100	2.7	0.21	0.0054
2012	357	29	68	1.7	0.11	0.0044
2013	111	17	21	1.0	0.13	0.0053
2014	510	49	41	1.9	0.20	0.0065
2015	541	62	76	2.7	0.17	0.0058
2016	359	49	58	2.3	0.16	0.0076
2017	202	31	36	2.7	0.18	0.012

Table 3.8. Predicted population numbers (numbers of fish) at age at the beginning of the year from the base run of the stock assessment model, 1991–2017.

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1991	226,690	168,260	188,106	233,819	63,912	25,981	13,654	9,380	6,190	3,942	2,602	2,091	1,583	1,047	721	502	336	528
1992	298,814	151,951	112,634	125,023	136,282	24,395	7,538	4,169	3,328	2,451	1,652	1,118	908	690	457	315	219	378
1993	779,868	200,297	101,736	75,069	77,339	64,844	9,498	2,946	1,778	1,527	1,172	806	550	448	341	226	156	295
1994	1,211,036	522,750	134,083	67,734	45,664	34,408	22,844	3,376	1,163	766	690	542	376	258	210	160	106	212
1995	875,700	811,762	349,814	89,216	41,084	19,718	11,354	7,542	1,252	478	333	309	246	171	118	96	73	146
1996	1,720,200	586,983	543,056	232,456	53,319	16,624	5,845	3,361	2,552	476	195	140	132	106	74	51	41	94
1997	850,404	1,153,053	392,701	360,342	138,727	21,982	5,069	1,757	1,136	961	191	81	59	56	45	31	22	58
1998	1,283,700	570,034	771,993	261,187	222,840	67,949	8,925	2,033	754	520	457	93	39	29	27	22	15	39
1999	564,216	860,478	381,751	514,639	162,098	108,982	27,753	3,635	887	349	249	222	45	19	14	13	11	27
2000	1,736,040	378,201	576,252	254,690	323,729	83,014	47,650	12,152	1,702	440	179	130	116	24	10	7	7	20
2001	582,912	1,163,685	253,259	384,410	157,504	153,276	32,110	18,429	5,091	762	205	85	62	56	11	5	4	13
2002	398,252	390,732	779,193	168,910	236,515	72,748	56,893	11,898	7,437	2,208	344	94	39	29	26	5	2	8
2003	157,198	266,953	261,601	519,606	103,739	108,157	26,827	21,318	4,941	3,354	1,042	166	46	19	14	13	3	5
2004	355,698	105,371	178,669	174,420	326,834	51,302	43,366	10,649	9,240	2,326	1,659	528	85	24	10	7	7	4
2005	889,434	238,426	70,529	118,948	106,898	148,739	18,382	15,420	4,162	3,930	1,039	759	244	40	11	5	3	5
2006	617,552	596,193	159,578	46,919	71,316	44,860	48,553	6,191	5,931	1,778	1,777	483	357	115	19	5	2	4
2007	642,528	413,945	398,816	106,011	27,249	25,795	11,768	13,588	2,106	2,341	760	788	217	162	52	8	2	3
2008	277,352	430,673	276,335	263,098	56,240	6,450	3,405	1,699	2,766	562	726	253	271	76	56	18	3	2
2009	75,442	185,910	288,136	183,127	153,665	21,566	1,767	911	513	931	202	268	95	102	29	21	7	2
2010	404,054	50,569	124,449	191,666	109,788	65,088	7,117	592	343	212	404	90	121	43	46	13	10	4
2011	809,868	270,836	33,815	82,579	113,573	42,732	18,416	2,083	207	139	94	186	42	57	20	22	6	6
2012	357,286	542,855	181,202	22,451	48,267	42,752	11,647	5,122	675	76	55	38	77	17	24	8	9	5
2013	110,836	239,483	362,573	119,121	10,411	6,946	2,761	821	530	93	12	9	7	14	3	4	2	3
2014	509,662	74,290	159,688	237,869	61,499	2,172	691	274	115	100	21	3	2	2	4	1	1	1
2015	541,110	341,625	49,683	105,708	137,920	22,681	561	177	82	39	37	8	1	1	1	1	0	1
2016	358,590	362,706	228,496	32,914	59,484	44,092	4,617	110	40	21	11	11	2	0	0	0	0	0
2017	201,758	240,360	242,368	151,168	18,131	16,999	7,995	913	29	13	8	4	4	1	0	0	0	0

Table 3.9. Predicted population numbers (numbers of fish) at age at mid-year from the base run of the stock assessment model, 1991–2017.

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1991	185,596	137,665	153,355	178,506	39,479	13,994	7,544	5,587	3,895	2,551	1,706	1,378	1,046	692	477	332	222	349
1992	244,646	124,334	91,953	98,331	93,998	15,222	4,712	2,722	2,255	1,695	1,154	784	638	486	322	222	154	266
1993	638,495	163,879	83,012	58,548	51,580	38,486	5,662	1,851	1,167	1,027	797	551	377	307	234	155	107	202
1994	991,500	427,629	109,372	52,752	30,003	19,764	13,126	2,056	745	505	462	365	254	174	142	108	72	143
1995	716,952	663,952	285,161	68,969	26,130	10,735	6,177	4,387	772	305	216	202	161	113	77	63	48	96
1996	1,408,361	480,113	442,364	179,575	34,230	9,179	3,204	1,954	1,566	302	125	91	86	69	48	33	27	61
1997	696,247	943,477	320,264	283,368	97,083	14,007	3,210	1,151	768	662	133	56	41	39	31	22	15	40
1998	1,050,997	466,488	630,316	205,761	155,829	43,425	5,696	1,342	513	359	318	65	28	20	19	15	11	27
1999	461,938	704,168	311,814	408,170	115,996	72,061	18,364	2,487	624	250	179	161	33	14	10	10	8	19
2000	1,421,338	309,488	470,656	200,285	222,738	51,628	29,633	7,865	1,139	300	123	89	80	16	7	5	5	14
2001	477,245	952,227	206,828	301,525	107,033	93,380	19,546	11,707	3,352	512	139	58	42	38	8	3	2	9
2002	326,059	319,712	636,296	132,372	159,925	44,176	34,825	7,667	4,994	1,517	239	66	27	20	18	4	2	5
2003	128,701	218,394	213,608	412,096	72,947	68,484	16,902	14,035	3,390	2,359	742	119	33	14	10	9	2	3
2004	291,217	86,208	145,782	136,546	220,461	30,708	25,859	6,657	6,026	1,554	1,123	359	58	16	7	5	4	3
2005	728,199	195,058	57,526	92,102	69,239	84,979	10,668	9,562	2,720	2,643	708	520	168	27	8	3	2	3
2006	505,602	487,618	130,066	35,756	42,880	22,975	25,683	3,610	3,726	1,162	1,183	324	240	78	13	4	1	3
2007	526,041	338,213	323,925	77,210	13,248	9,370	4,470	6,127	1,088	1,303	438	462	128	96	31	5	1	2
2008	227,074	352,268	224,954	201,066	34,819	3,376	1,762	933	1,604	337	441	155	166	46	35	11	2	1
2009	61,766	152,106	235,001	141,791	99,996	12,389	1,023	559	329	614	134	180	64	68	19	14	5	1
2010	330,805	41,352	101,375	147,538	68,481	34,620	3,850	350	218	141	274	61	83	29	32	9	7	3
2011	663,054	221,530	27,553	63,132	69,667	22,308	9,712	1,185	125	87	60	120	27	37	13	14	4	4
2012	292,513	443,650	146,918	15,287	18,284	10,862	3,091	1,646	251	30	23	16	32	7	10	4	4	2
2013	90,741	195,557	293,675	85,586	4,751	2,190	870	306	230	44	6	5	3	7	2	2	1	1
2014	417,269	60,753	129,924	181,124	37,339	1,104	350	150	67	61	13	2	1	1	2	1	1	1
2015	443,017	279,392	40,438	79,294	77,954	10,232	249	84	42	21	20	4	1	1	0	1	0	0
2016	293,582	296,493	185,853	24,428	31,785	18,774	2,053	56	23	13	7	7	1	0	0	0	0	0
2017	165,182	196,503	197,152	114,032	10,402	7,901	3,755	476	16	8	5	3	3	1	0	0	0	0

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Table 3.10. Predicted landings at age (numbers of fish) for the ARcomm fleet from the base run of the stock assessment model, 1991–2017.

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1991	1	71	343	5,471	6,939	4,564	2,537	1,507	802	424	249	188	139	91	62	43	29	46
1992	1	56	180	2,626	14,205	4,219	1,355	632	401	244	146	93	73	55	36	25	17	30
1993	3	84	185	1,781	8,912	12,240	1,869	492	237	168	115	74	49	40	30	20	14	26
1994	6	280	310	2,048	6,627	8,068	5,564	702	194	106	85	63	43	29	24	18	12	24
1995	5	509	948	3,137	6,788	5,182	3,098	1,768	237	75	47	41	32	22	15	12	9	19
1996	9	353	1,410	7,831	8,514	4,236	1,538	755	461	72	26	18	16	13	9	6	5	11
1997	3	414	609	7,365	14,253	3,764	897	261	133	93	16	6	5	4	3	2	2	4
1998	3	163	953	4,251	18,195	9,279	1,264	242	71	40	31	6	2	2	2	1	1	2
1999	2	253	485	8,674	13,903	15,772	4,171	458	88	29	18	15	3	1	1	1	1	2
2000	5	121	796	4,627	29,136	12,388	7,379	1,585	176	37	13	9	8	2	1	1	0	1
2001	2	401	377	7,519	15,131	24,258	5,271	2,552	560	69	16	6	5	4	1	0	0	1
2002	1	149	1,284	3,653	25,030	12,703	10,383	1,845	920	226	31	8	3	2	2	0	0	1
2003	1	130	553	14,578	14,580	25,101	6,437	4,322	799	449	124	19	5	2	2	1	0	1
2004	1	48	351	4,496	41,186	10,561	9,239	1,921	1,330	277	175	53	8	2	1	1	1	0
2005	4	113	145	3,178	13,613	30,847	4,009	2,893	628	492	116	80	25	4	1	0	0	0
2006	4	388	448	1,689	11,656	11,653	13,435	1,508	1,183	297	265	68	49	16	3	1	0	1
2007	8	540	2,241	7,346	7,529	10,445	5,107	5,422	717	686	201	198	53	39	13	2	1	1
2008	1	252	698	8,544	8,469	1,531	834	354	463	78	90	30	31	9	6	2	0	0
2009	0	79	527	4,351	17,469	3,992	342	151	68	102	20	25	8	9	3	2	1	0
2010	3	39	413	8,231	21,876	20,587	2,371	173	82	42	72	15	20	7	8	2	2	1
2011	4	160	86	2,714	17,182	10,254	4,629	453	37	20	12	23	5	7	2	3	1	1
2012	4	616	885	1,276	9,669	12,003	3,488	1,407	157	15	10	6	13	3	4	1	1	1
2013	2	396	2,580	10,352	3,474	3,242	1,343	363	200	31	4	3	2	4	1	1	0	1
2014	3	53	492	9,393	11,112	614	203	70	24	17	3	0	0	0	0	0	0	0
2015	3	234	147	3,949	22,544	5,624	143	39	15	6	5	1	0	0	0	0	0	0
2016	3	358	974	1,758	13,414	15,131	1,701	37	11	5	2	2	0	0	0	0	0	0
2017	2	220	955	7,576	4,002	5,752	2,837	286	7	3	2	1	1	0	0	0	0	0

Table 3.11. Predicted dead discards at age (numbers of fish) for the ARcomm fleet from the base run of the stock assessment model, 1991–2017.

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1991	3	112	257	856	714	376	163	70	24	7	2	1	0	0	0	0	0	0
1992	3	88	135	411	1,462	348	87	29	12	4	1	0	0	0	0	0	0	0
1993	9	133	138	279	917	1,008	121	23	7	3	1	0	0	0	0	0	0	0
1994	19	442	232	321	682	665	359	33	6	2	1	0	0	0	0	0	0	0
1995	16	804	710	491	699	427	200	82	7	1	0	0	0	0	0	0	0	0
1996	30	557	1,055	1,226	876	349	99	35	14	1	0	0	0	0	0	0	0	0
1997	9	653	456	1,153	1,467	310	58	12	4	2	0	0	0	0	0	0	0	0
1998	11	257	713	665	1,872	764	82	11	2	1	0	0	0	0	0	0	0	0
1999	5	399	363	1,358	1,431	1,299	269	21	3	0	0	0	0	0	0	0	0	0
2000	16	190	596	724	2,998	1,020	476	74	5	1	0	0	0	0	0	0	0	0
2001	6	633	282	1,177	1,557	1,998	340	119	17	1	0	0	0	0	0	0	0	0
2002	4	235	961	572	2,576	1,047	670	86	27	4	0	0	0	0	0	0	0	0
2003	2	206	414	2,282	1,500	2,068	415	201	24	8	1	0	0	0	0	0	0	0
2004	5	76	263	704	4,238	870	596	89	40	5	2	0	0	0	0	0	0	0
2005	12	179	109	497	1,401	2,541	259	135	19	8	1	0	0	0	0	0	0	0
2006	12	612	336	264	1,200	960	866	70	35	5	2	0	0	0	0	0	0	0
2007	24	852	1,678	1,150	775	861	329	252	21	12	2	1	0	0	0	0	0	0
2008	5	398	522	1,337	872	126	54	16	14	1	1	0	0	0	0	0	0	0
2009	1	124	395	681	1,798	329	22	7	2	2	0	0	0	0	0	0	0	0
2010	9	61	309	1,288	2,252	1,696	153	8	2	1	1	0	0	0	0	0	0	0
2011	14	253	65	425	1,768	845	299	21	1	0	0	0	0	0	0	0	0	0
2012	12	973	663	200	996	990	225	65	5	0	0	0	0	0	0	0	0	0
2013	5	625	1,931	1,620	358	268	87	17	6	1	0	0	0	0	0	0	0	0
2014	11	84	368	1,470	1,144	51	13	3	1	0	0	0	0	0	0	0	0	0
2015	11	369	110	618	2,321	464	9	2	0	0	0	0	0	0	0	0	0	0
2016	10	566	729	275	1,381	1,248	110	2	0	0	0	0	0	0	0	0	0	0
2017	5	347	715	1,186	412	474	183	13	0	0	0	0	0	0	0	0	0	0

Table 3.12. Predicted harvest at age (numbers of fish) for the ASrec fleet from the base run of the stock assessment model, 1991–2017.

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1991	0	0	76	3,143	3,292	2,256	1,548	1,232	876	576	385	311	236	156	108	75	50	79
1992	0	0	31	1,198	5,351	1,656	656	411	348	263	179	122	99	76	50	34	24	41
1993	0	0	33	834	3,448	4,933	928	328	211	187	145	100	69	56	43	28	19	37
1994	0	0	45	767	2,049	2,598	2,207	373	138	94	86	68	47	32	27	20	13	27
1995	0	0	130	1,120	2,002	1,592	1,172	897	161	64	45	42	34	24	16	13	10	20
1996	0	0	174	2,520	2,263	1,172	524	345	282	55	23	16	16	12	9	6	5	11
1997	0	0	66	2,072	3,312	911	267	104	71	62	12	5	4	4	3	2	1	4
1998	0	0	241	2,804	9,911	5,266	883	226	89	62	55	11	5	4	3	3	2	5
1999	0	0	80	3,742	4,953	5,854	1,908	281	72	29	21	19	4	2	1	1	1	2
2000	0	0	232	3,507	18,238	8,080	5,931	1,707	253	67	28	20	18	4	2	1	1	3
2001	0	0	113	5,851	9,724	16,241	4,349	2,823	827	127	34	14	10	9	2	1	1	2
2002	0	0	266	1,968	11,135	5,888	5,929	1,413	941	287	45	12	5	4	3	1	0	1
2003	0	0	50	3,423	2,827	5,071	1,602	1,442	356	249	79	13	3	1	1	1	0	0
2004	0	0	59	1,964	14,858	3,969	4,278	1,192	1,103	286	207	66	11	3	1	1	1	0
2005	0	0	19	1,089	3,854	9,097	1,457	1,409	409	399	107	79	25	4	1	0	0	1
2006	0	0	44	431	2,457	2,558	3,635	547	574	179	183	50	37	12	2	1	0	0
2007	0	0	150	1,281	1,084	1,566	944	1,346	238	283	95	100	28	21	7	1	0	0
2008	0	0	134	4,283	3,506	660	442	253	442	93	122	43	46	13	10	3	1	0
2009	0	0	104	2,230	7,394	1,759	186	110	66	124	27	36	13	14	4	3	1	0
2010	0	0	12	607	1,332	1,306	185	18	11	7	14	3	4	2	2	0	0	0
2011	0	0	14	1,147	5,995	3,726	2,072	272	29	20	14	28	6	9	3	3	1	1
2012	0	0	290	1,088	6,812	8,805	3,152	1,706	255	30	23	16	32	7	10	4	4	2
2013	0	0	219	2,285	633	615	314	114	84	16	2	2	1	2	1	1	0	0
2014	0	0	53	2,636	2,576	148	60	28	13	11	2	0	0	0	0	0	0	0
2015	0	0	47	3,310	15,606	4,053	127	46	23	11	11	2	0	0	0	0	0	0
2016	0	0	64	300	1,889	2,219	307	9	4	2	1	1	0	0	0	0	0	0
2017	0	0	79	1,627	710	1,062	645	87	3	1	1	0	0	0	0	0	0	0

Table 3.13. Predicted dead discards at age (numbers of fish) for the ASrec fleet from the base run of the stock assessment model, 1991–2017.

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1991	0	0	42	789	457	175	63	23	7	2	1	0	0	0	0	0	0	0
1992	0	0	17	301	743	129	27	8	3	1	0	0	0	0	0	0	0	0
1993	0	0	18	210	479	384	38	6	2	1	0	0	0	0	0	0	0	0
1994	0	0	25	193	284	202	90	7	1	0	0	0	0	0	0	0	0	0
1995	0	0	72	281	278	124	48	17	1	0	0	0	0	0	0	0	0	0
1996	0	0	96	633	314	91	21	7	2	0	0	0	0	0	0	0	0	0
1997	0	0	36	521	460	71	11	2	1	0	0	0	0	0	0	0	0	0
1998	0	0	133	704	1,376	410	36	4	1	0	0	0	0	0	0	0	0	0
1999	0	0	44	940	687	455	77	5	1	0	0	0	0	0	0	0	0	0
2000	0	0	128	881	2,531	628	241	33	2	0	0	0	0	0	0	0	0	0
2001	0	0	62	1,470	1,350	1,263	176	54	7	0	0	0	0	0	0	0	0	0
2002	0	0	147	494	1,546	458	241	27	8	1	0	0	0	0	0	0	0	0
2003	0	0	28	860	392	395	65	28	3	1	0	0	0	0	0	0	0	0
2004	0	0	32	493	2,062	309	174	23	9	1	0	0	0	0	0	0	0	0
2005	0	0	11	274	535	708	59	27	3	1	0	0	0	0	0	0	0	0
2006	0	0	24	108	341	199	148	10	5	1	0	0	0	0	0	0	0	0
2007	0	0	83	322	151	122	38	26	2	1	0	0	0	0	0	0	0	0
2008	0	0	74	1,076	487	52	18	5	4	0	0	0	0	0	0	0	0	0
2009	0	0	57	560	1,027	137	8	2	1	0	0	0	0	0	0	0	0	0
2010	0	0	6	152	185	102	8	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	8	288	832	290	84	5	0	0	0	0	0	0	0	0	0	0
2012	0	0	160	273	947	686	128	33	2	0	0	0	0	0	0	0	0	0
2013	0	0	121	574	88	48	13	2	1	0	0	0	0	0	0	0	0	0
2014	0	0	29	662	358	12	2	1	0	0	0	0	0	0	0	0	0	0
2015	0	0	26	832	2,167	316	5	1	0	0	0	0	0	0	0	0	0	0
2016	0	0	35	75	262	173	13	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	43	409	99	83	26	2	0	0	0	0	0	0	0	0	0	0

Table 3.14. Predicted harvest at age (numbers of fish) for the RRrec fleet from the base run of the stock assessment model, 1991–2017.

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1991	0	0	150	11,196	9,646	4,067	1,353	413	90	14	2	0	0	0	0	0	0	0
1992	0	0	35	2,402	8,825	1,683	323	77	20	4	0	0	0	0	0	0	0	0
1993	0	0	41	1,851	6,293	5,551	509	69	13	3	0	0	0	0	0	0	0	0
1994	0	0	47	1,449	3,186	2,491	1,031	67	7	1	0	0	0	0	0	0	0	0
1995	0	0	134	2,078	3,055	1,498	537	158	9	1	0	0	0	0	0	0	0	0
1996	0	0	154	4,022	2,971	950	207	52	13	1	0	0	0	0	0	0	0	0
1997	0	0	64	3,609	4,745	805	115	17	4	1	0	0	0	0	0	0	0	0
1998	0	0	221	4,628	13,454	4,405	361	36	4	1	0	0	0	0	0	0	0	0
1999	0	0	89	7,427	8,085	5,888	934	53	4	0	0	0	0	0	0	0	0	0
2000	0	0	202	5,501	23,526	6,421	2,294	254	12	1	0	0	0	0	0	0	0	0
2001	0	0	94	8,769	11,985	12,336	1,607	401	36	1	0	0	0	0	0	0	0	0
2002	0	0	338	4,512	20,998	6,843	3,355	307	62	5	0	0	0	0	0	0	0	0
2003	0	0	35	4,297	2,919	3,227	496	172	13	2	0	0	0	0	0	0	0	0
2004	0	0	50	2,987	18,583	3,060	1,607	172	48	3	0	0	0	0	0	0	0	0
2005	0	0	39	3,958	11,518	16,758	1,306	486	43	10	1	0	0	0	0	0	0	0
2006	0	0	131	2,306	10,811	6,941	4,797	277	88	7	1	0	0	0	0	0	0	0
2007	0	0	470	7,232	5,037	4,490	1,315	716	38	11	1	0	0	0	0	0	0	0
2008	0	0	102	5,843	3,936	458	150	33	17	1	0	0	0	0	0	0	0	0
2009	0	0	144	5,561	15,168	2,229	115	26	5	2	0	0	0	0	0	0	0	0
2010	0	0	60	5,631	10,168	6,147	425	16	3	0	0	0	0	0	0	0	0	0
2011	0	0	20	2,975	12,797	4,907	1,329	67	2	0	0	0	0	0	0	0	0	0
2012	0	0	376	2,545	13,113	10,458	1,823	378	17	1	0	0	0	0	0	0	0	0
2013	0	0	281	5,284	1,206	725	180	25	6	0	0	0	0	0	0	0	0	0
2014	0	0	67	5,976	4,805	171	34	6	1	0	0	0	0	0	0	0	0	0
2015	0	0	29	3,628	14,074	2,258	35	5	1	0	0	0	0	0	0	0	0	0
2016	0	0	244	2,061	10,685	7,749	524	6	1	0	0	0	0	0	0	0	0	0
2017	0	0	146	5,436	1,952	1,804	535	28	0	0	0	0	0	0	0	0	0	0

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Table 3.15. Predicted dead discards at age (numbers of fish) for the RRrec fleet from the base run of the stock assessment model, 1991–2017.

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1991	0	7	446	3,809	2,058	1,043	624	470	327	214	143	115	87	58	40	28	19	29
1992	0	3	132	1,034	2,383	546	189	112	93	69	47	32	26	20	13	9	6	11
1993	0	5	153	789	1,683	1,782	292	98	62	54	42	29	20	16	12	8	6	11
1994	0	11	156	551	760	713	529	85	31	21	19	15	10	7	6	4	3	6
1995	0	20	505	895	825	486	312	226	40	16	11	10	8	6	4	3	2	5
1996	0	31	1,636	4,868	2,255	865	338	210	168	32	13	10	9	7	5	4	3	7
1997	0	65	1,288	8,341	6,878	1,400	359	132	88	76	15	6	5	4	4	3	2	5
1998	0	16	1,235	2,951	5,381	2,116	310	75	29	20	18	4	2	1	1	1	1	2
1999	0	16	421	4,036	2,756	2,410	685	95	24	10	7	6	1	1	0	0	0	1
2000	0	4	339	1,057	2,836	930	596	162	24	6	3	2	2	0	0	0	0	0
2001	0	10	123	1,309	1,122	1,387	324	199	57	9	2	1	1	1	0	0	0	0
2002	0	3	327	499	1,456	570	501	113	74	22	4	1	0	0	0	0	0	0
2003	0	1	72	1,013	432	573	158	134	33	23	7	1	0	0	0	0	0	0
2004	0	3	250	1,713	6,684	1,321	1,243	327	296	76	55	18	3	1	0	0	0	0
2005	0	7	119	1,393	2,542	4,440	620	567	161	156	42	31	10	2	0	0	0	0
2006	0	13	195	393	1,155	890	1,103	157	161	50	51	14	10	3	1	0	0	0
2007	0	11	590	1,036	453	484	254	342	59	70	23	25	7	5	2	0	0	0
2008	0	29	1,060	6,951	2,937	409	239	129	221	46	60	21	23	6	5	2	0	0
2009	0	7	592	2,618	4,480	789	73	41	24	44	10	13	5	5	1	1	0	0
2010	0	2	234	2,492	2,823	2,047	253	23	14	9	18	4	5	2	2	1	0	0
2011	0	10	72	1,206	3,255	1,497	726	90	9	7	4	9	2	3	1	1	0	0
2012	0	26	507	392	1,266	1,211	378	193	28	3	2	2	4	1	1	0	0	0
2013	0	14	1,231	2,646	379	272	121	42	30	6	1	1	0	1	0	0	0	0
2014	0	5	632	6,463	3,260	139	49	21	10	9	2	0	0	0	0	0	0	0
2015	0	14	120	1,731	4,213	810	22	8	4	2	2	0	0	0	0	0	0	0
2016	0	11	410	396	1,289	1,121	135	4	1	1	0	0	0	0	0	0	0	0
2017	0	11	634	2,693	607	672	356	45	2	1	0	0	0	0	0	0	0	0

Table 3.16. Annual estimates of fishing mortality (numbers-weighted, ages 3–5) and associated standard deviations (SDs) from the base run of the stock assessment model, 1991–2017.

Year	Fishing Mortality	
	Value	SD
1991	0.25	0.015
1992	0.23	0.012
1993	0.35	0.021
1994	0.32	0.020
1995	0.28	0.019
1996	0.20	0.012
1997	0.15	0.0082
1998	0.21	0.012
1999	0.15	0.0071
2000	0.26	0.013
2001	0.24	0.012
2002	0.29	0.017
2003	0.15	0.0066
2004	0.30	0.0099
2005	0.42	0.011
2006	0.52	0.026
2007	0.48	0.030
2008	0.21	0.013
2009	0.28	0.015
2010	0.34	0.0094
2011	0.44	0.010
2012	1.3	0.057
2013	0.35	0.023
2014	0.23	0.0091
2015	0.50	0.017
2016	0.75	0.045
2017	0.27	0.025

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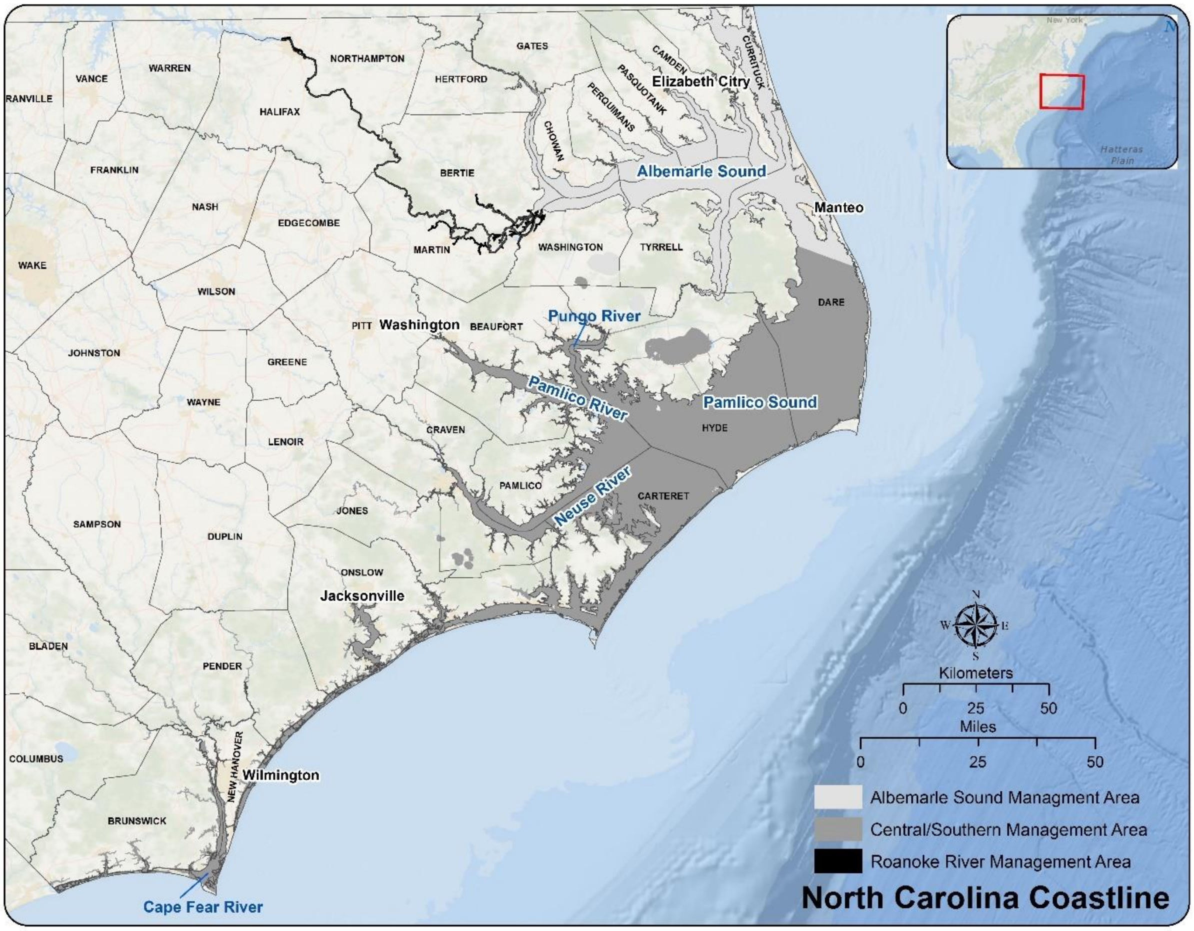

Figure 1.1. Boundary lines defining the Albemarle Sound Management Area, Central-Southern Management Area, and the Roanoke River Management Area.

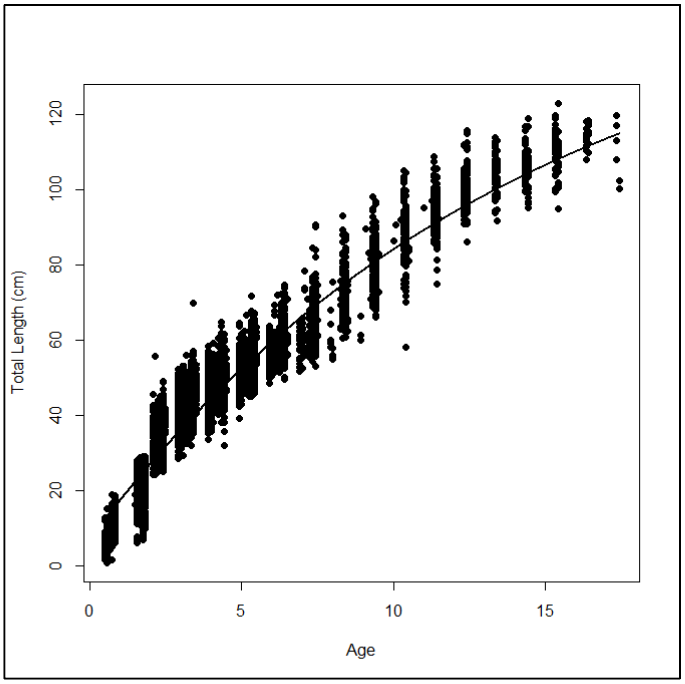

Figure 1.2. Fit of the age-length function to available age data for female striped bass.

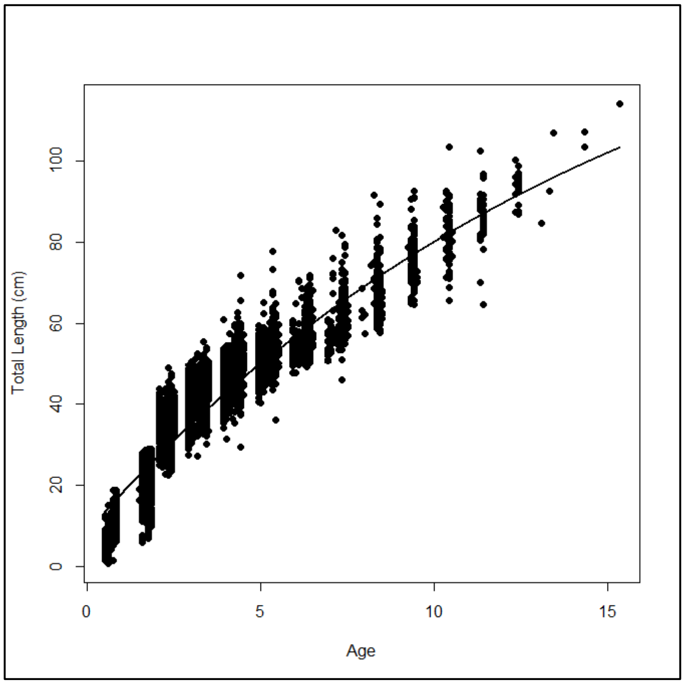

Figure 1.3. Fit of the age-length function to available age data for male striped bass.

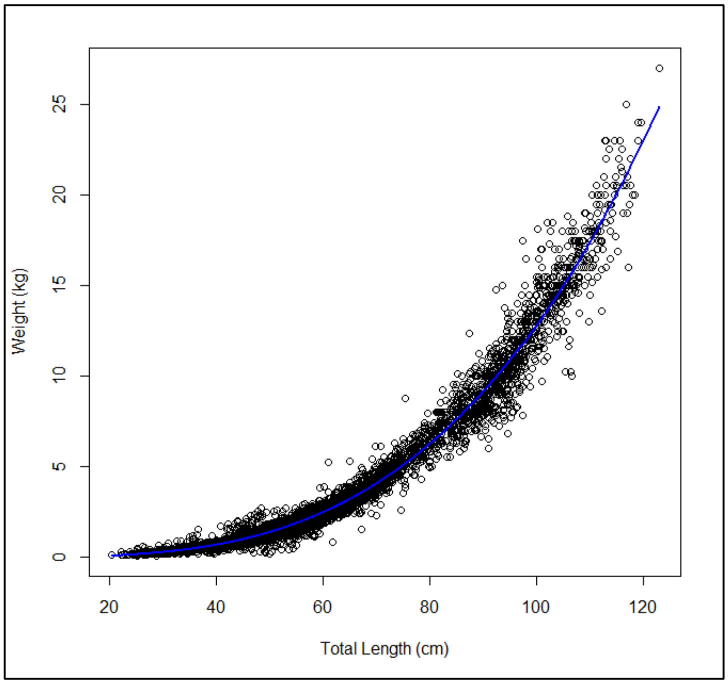

Figure 1.4. Fit of the length-weight function to available biological data for female striped bass.

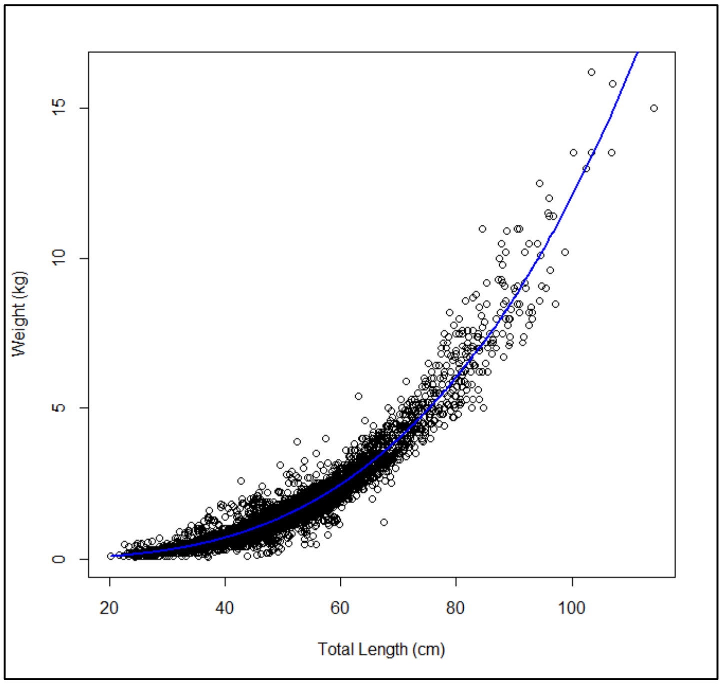

Figure 1.5. Fit of the length-weight function to available biological data for male striped bass.

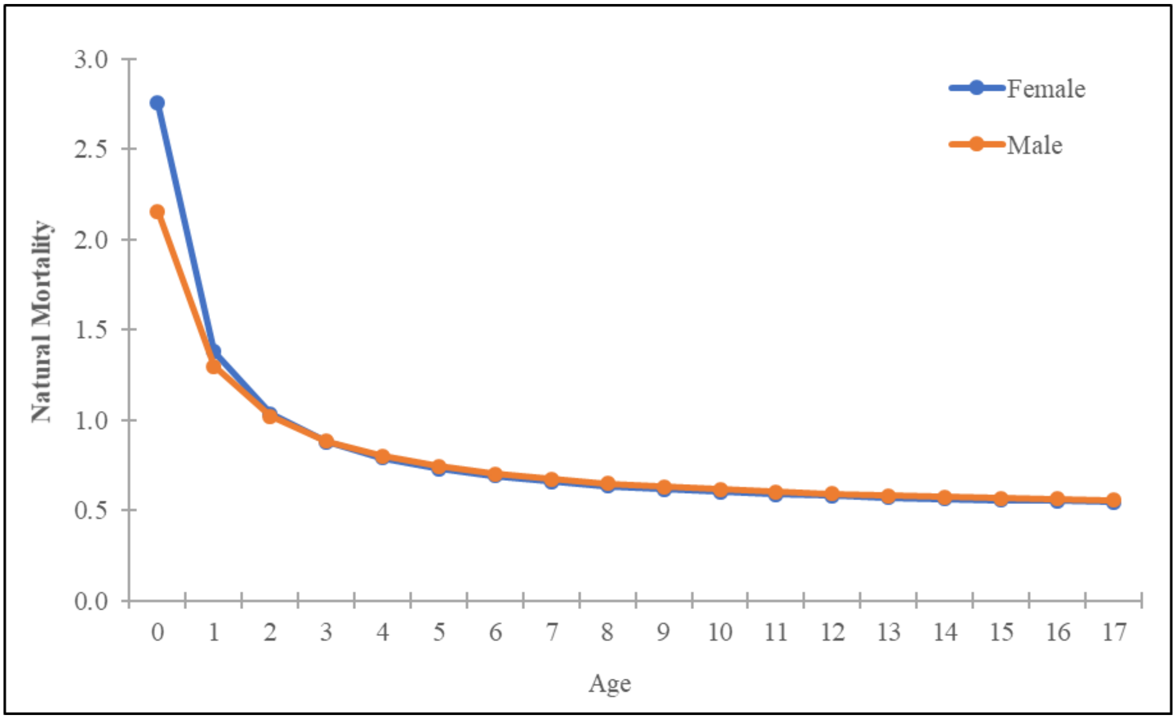

Figure 1.6. Estimates of natural mortality at age based on the method of Lorenzen (1996).

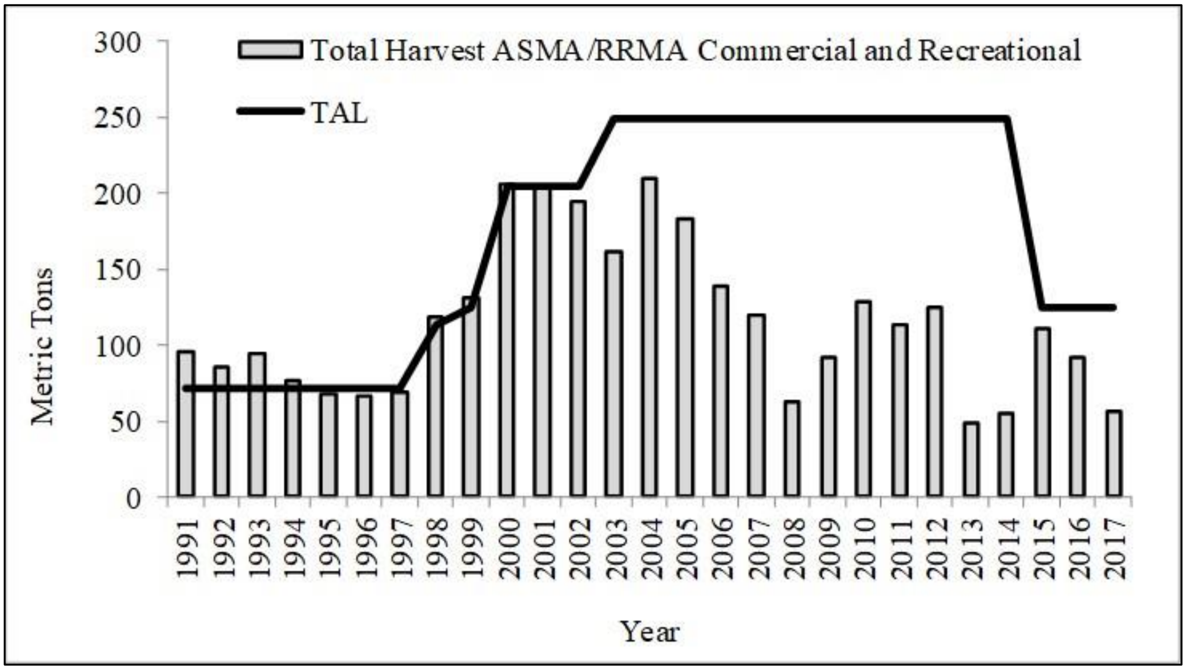

Figure 1.7. Annual total landings/harvest in metric tons of striped bass from the ASMA and RRMA commercial and recreational sectors combined compared to the TAL, 1991–2017.

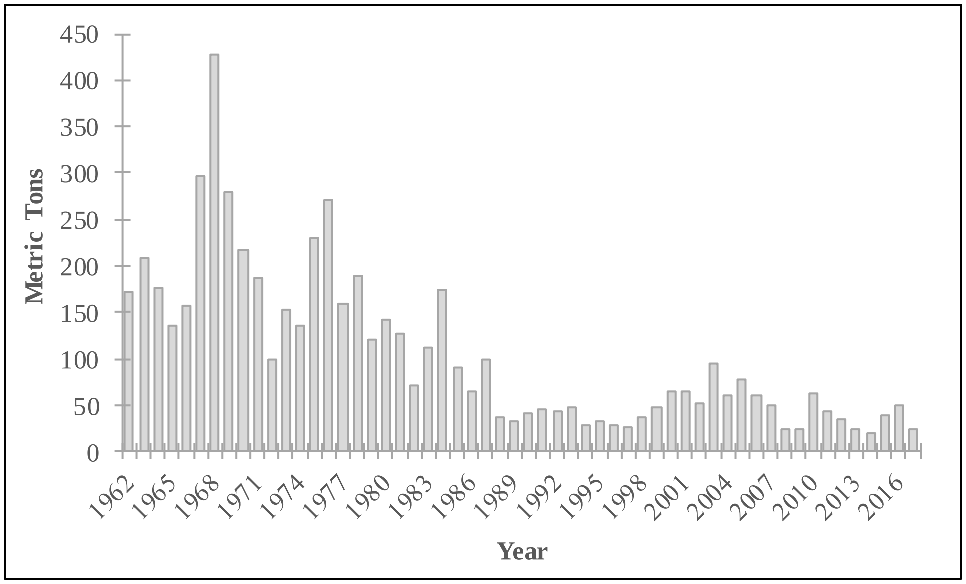

Figure 2.1. Annual commercial landings of striped bass in the ASMA-RRMA, 1962–2017.

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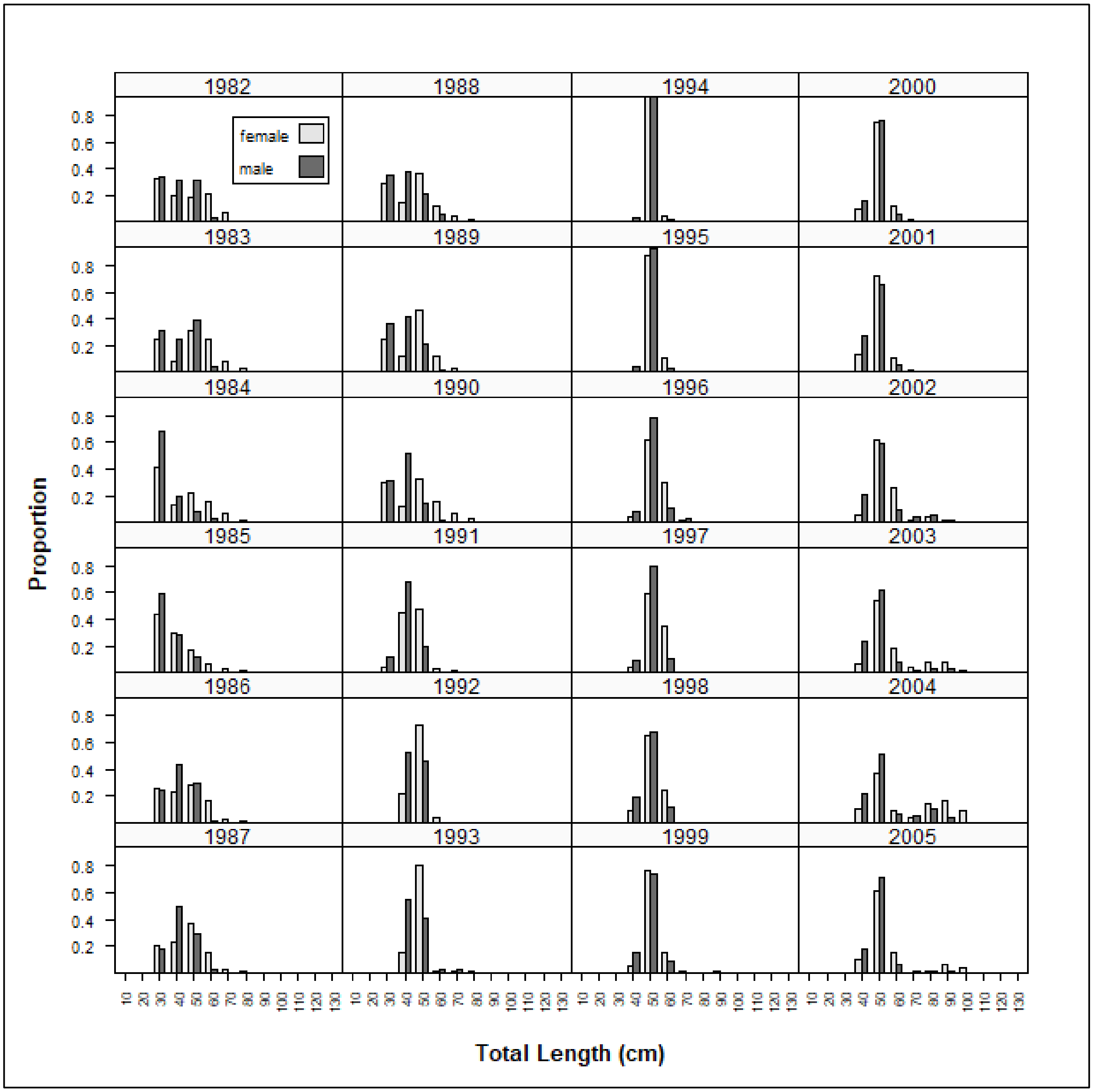

Figure 2.2. Annual length frequencies of striped bass commercial landings, 1982–2005.

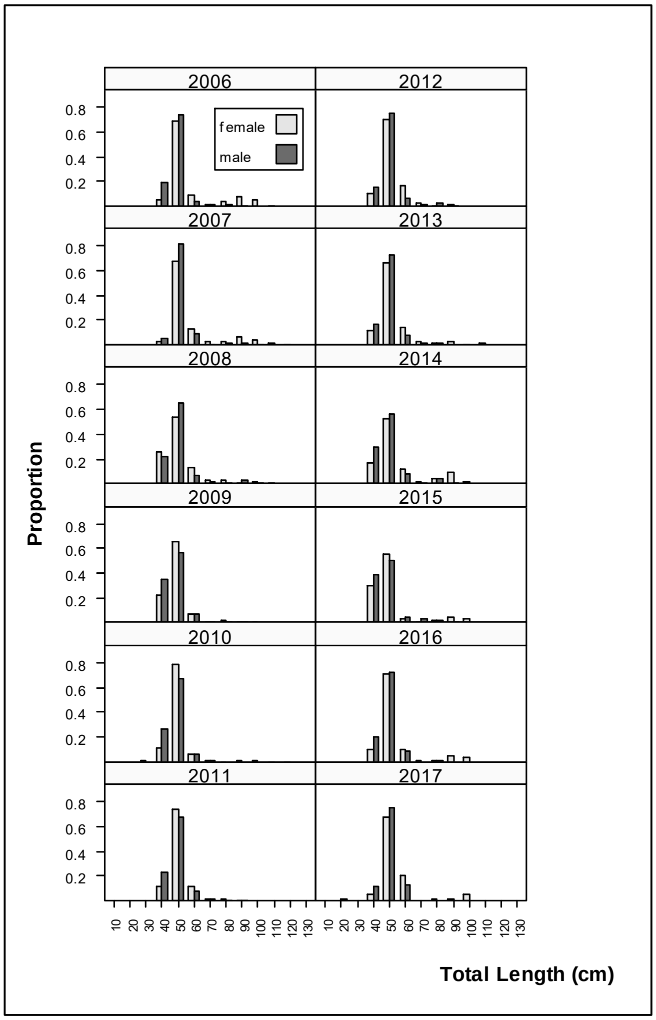

Figure 2.3. Annual length frequencies of striped bass commercial landings, 2006–2017.

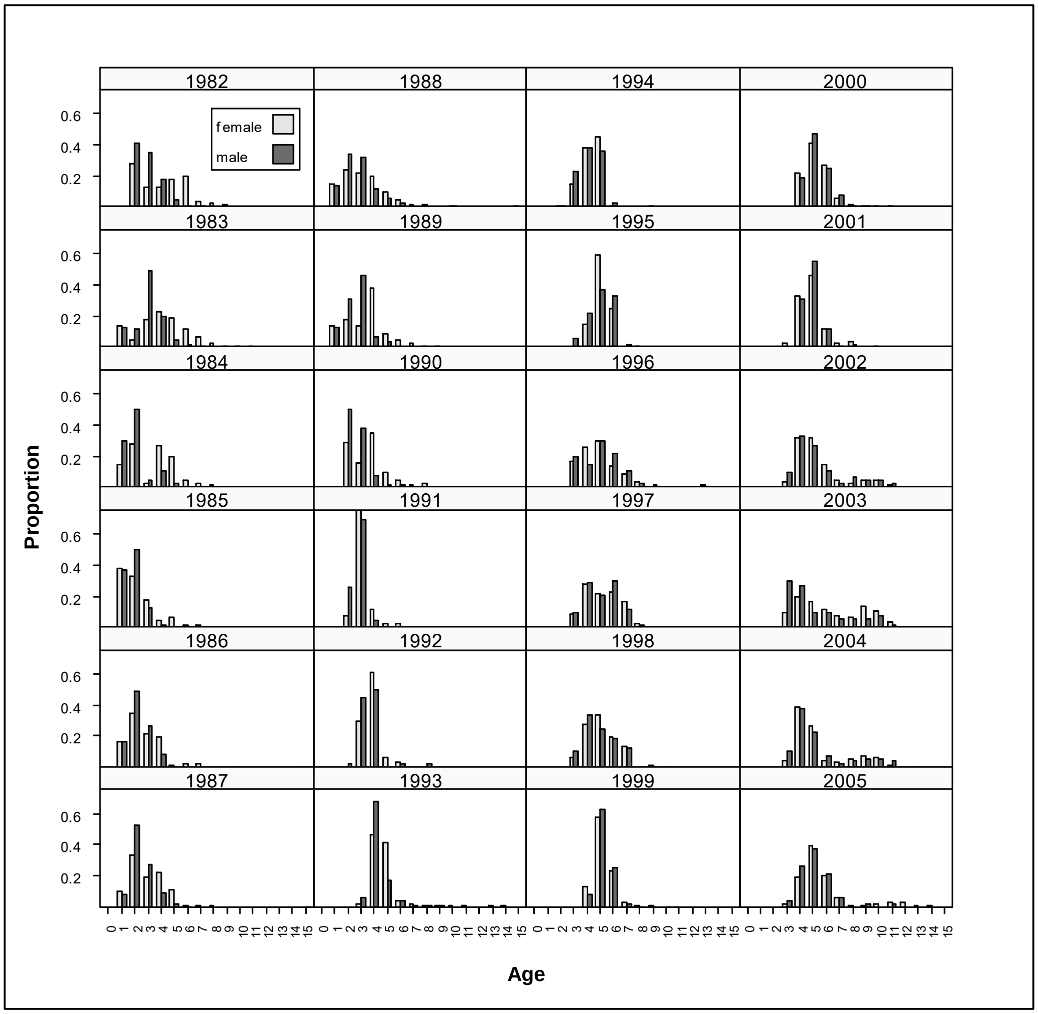

Figure 2.4. Annual age frequencies of striped bass commercial landings, 1982–2005. The age-15 bin represents a plus group.

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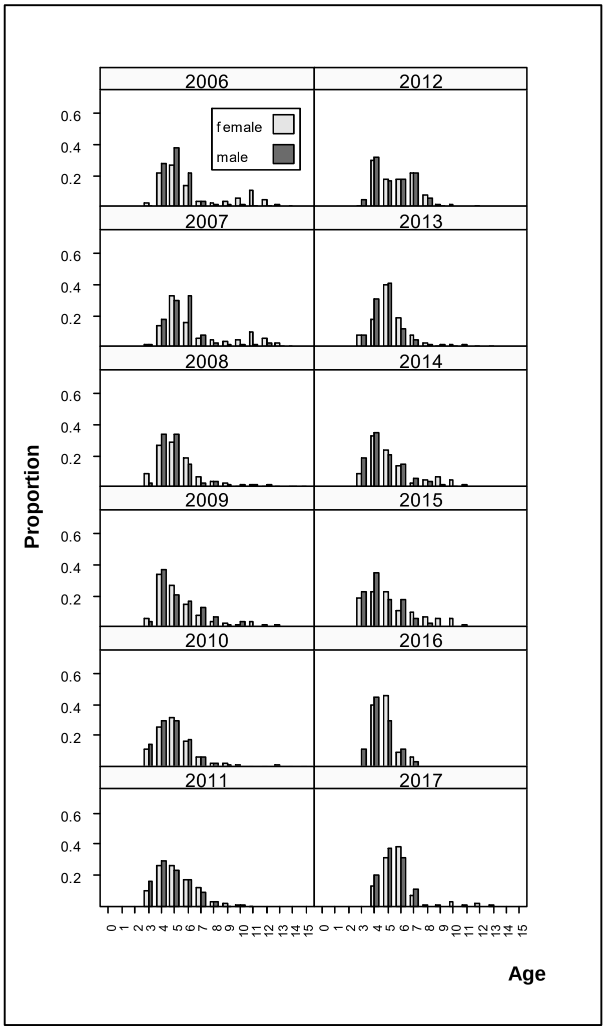

Figure 2.5. Annual age frequencies of striped bass commercial landings, 2006–2017. The age-15 bin represents a plus group.

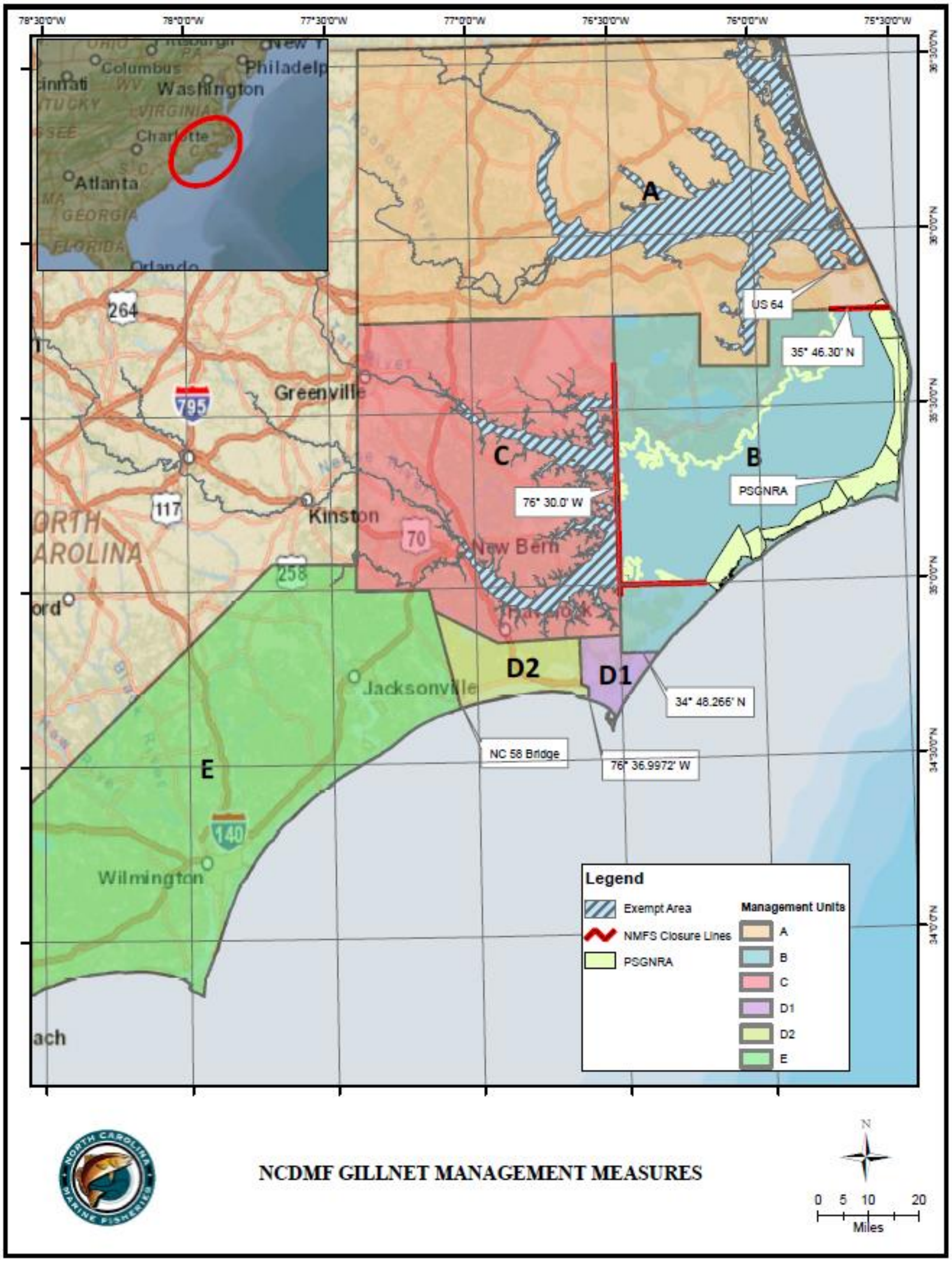

Figure 2.6. Management areas used in development of GLM for commercial gill-net discards.

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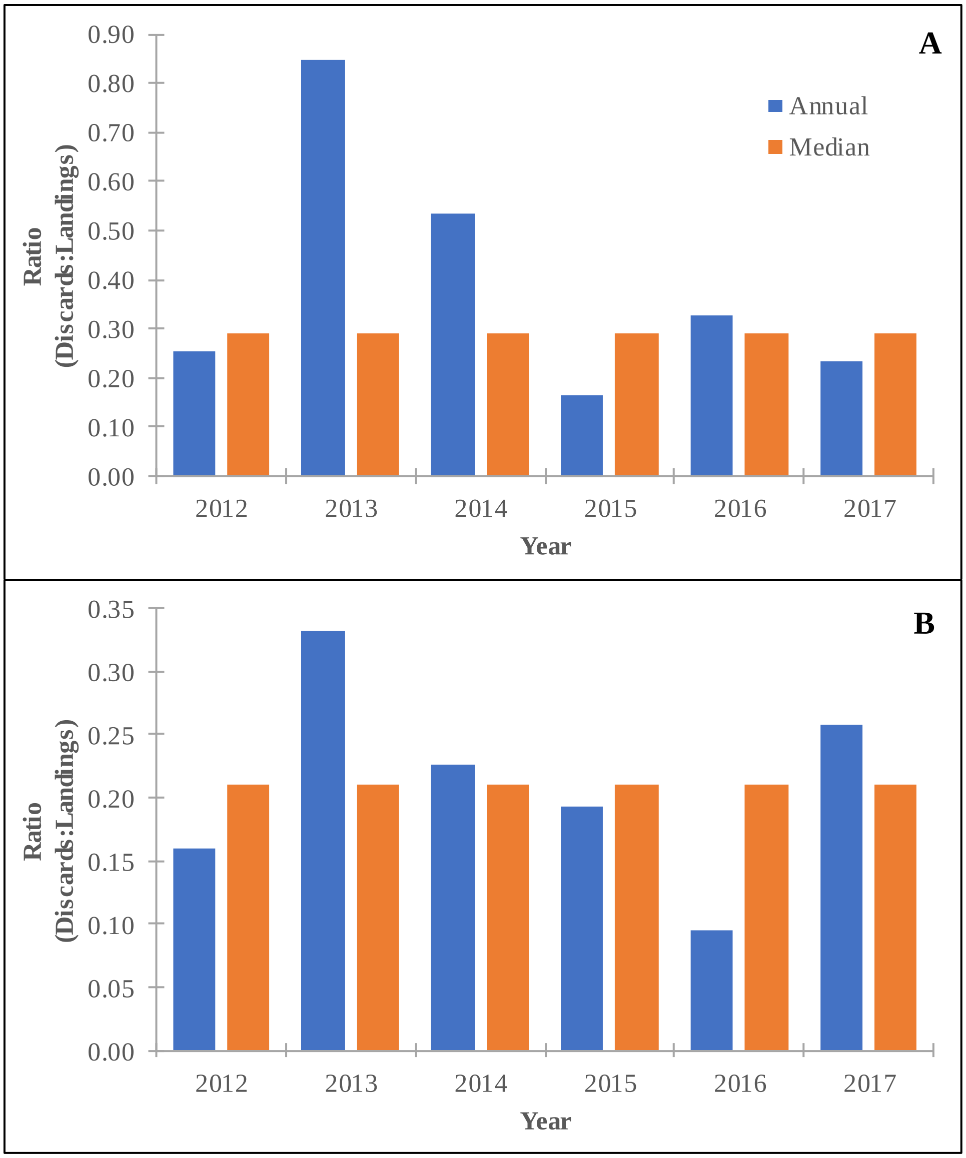

Figure 2.7. Ratio of commercial (A) live and (B) dead discards to commercial landings, 2012–2017.

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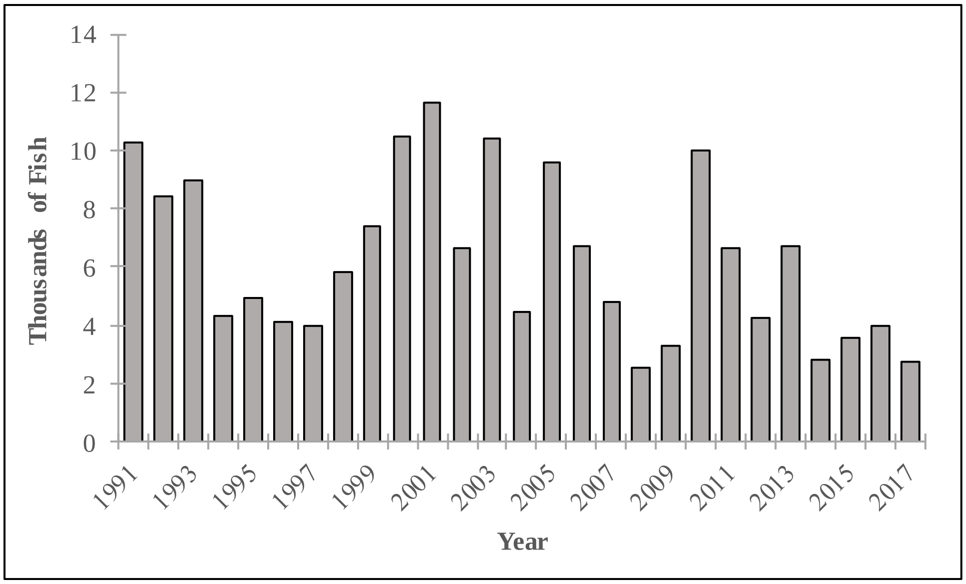

Figure 2.8. Annual estimates of commercial gill-net discards, 1991–2017. Note that values prior to 2012 were estimated using a hindcasting approach.

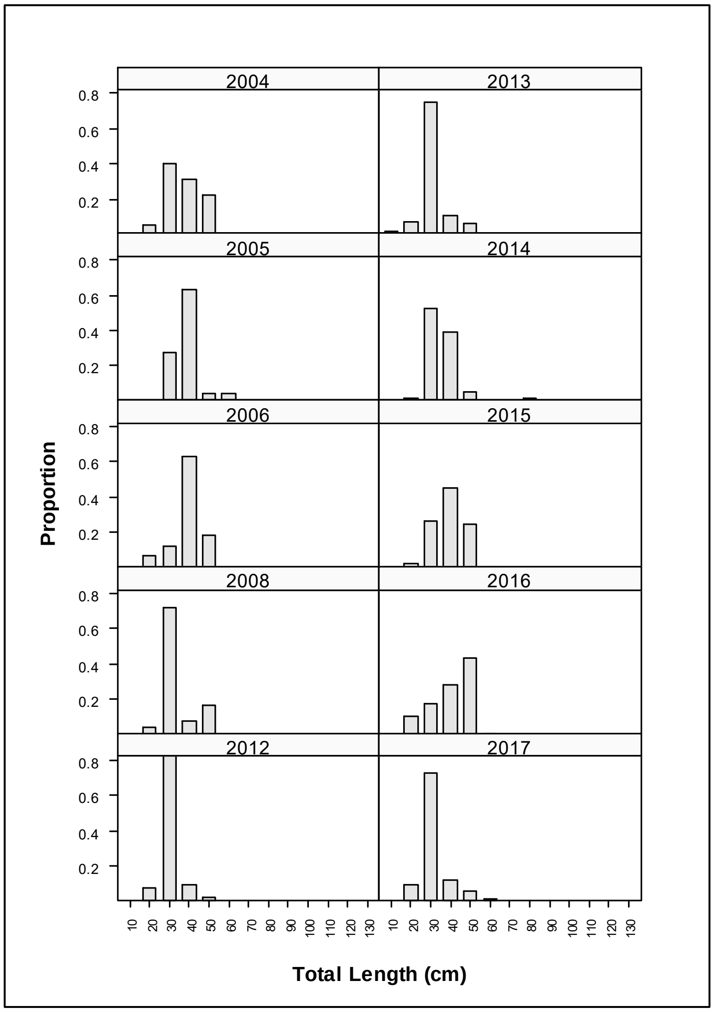

Figure 2.9. Annual length frequencies of striped bass commercial gill-net discards, 2004–2017.

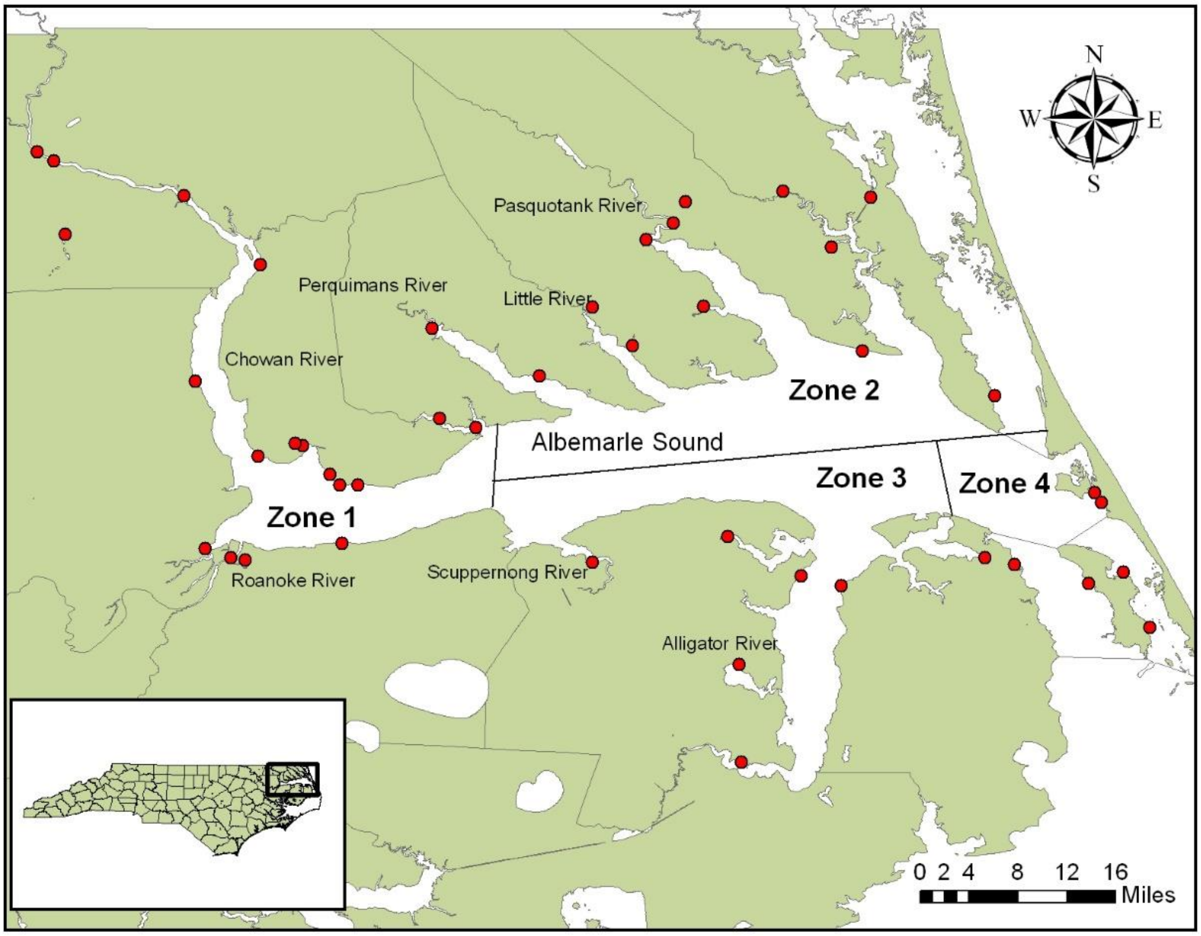

Figure 2.10. Sampling zones and access sites of the striped bass recreational creel survey in the ASMA.

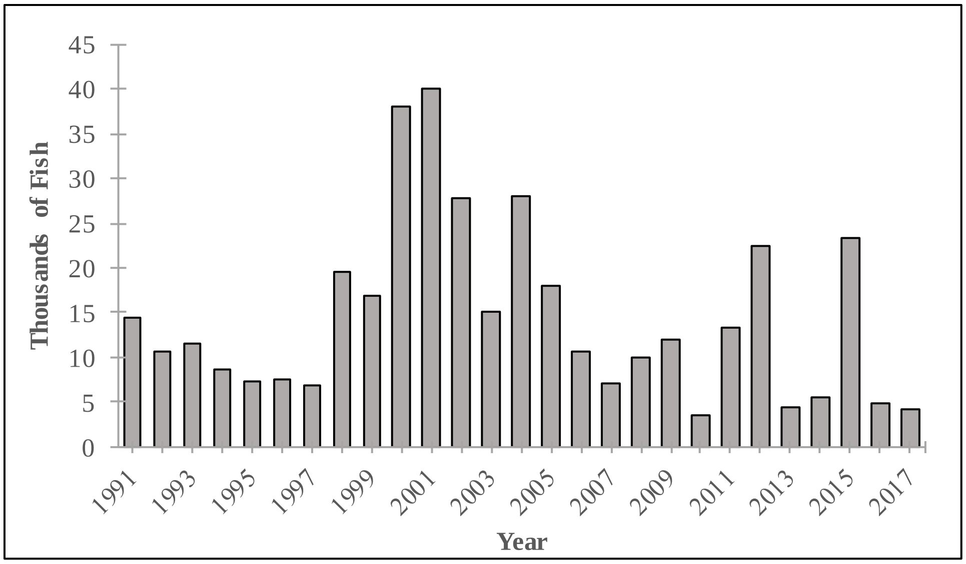

Figure 2.11. Annual estimates of recreational harvest for the Albemarle Sound, 1991–2017.

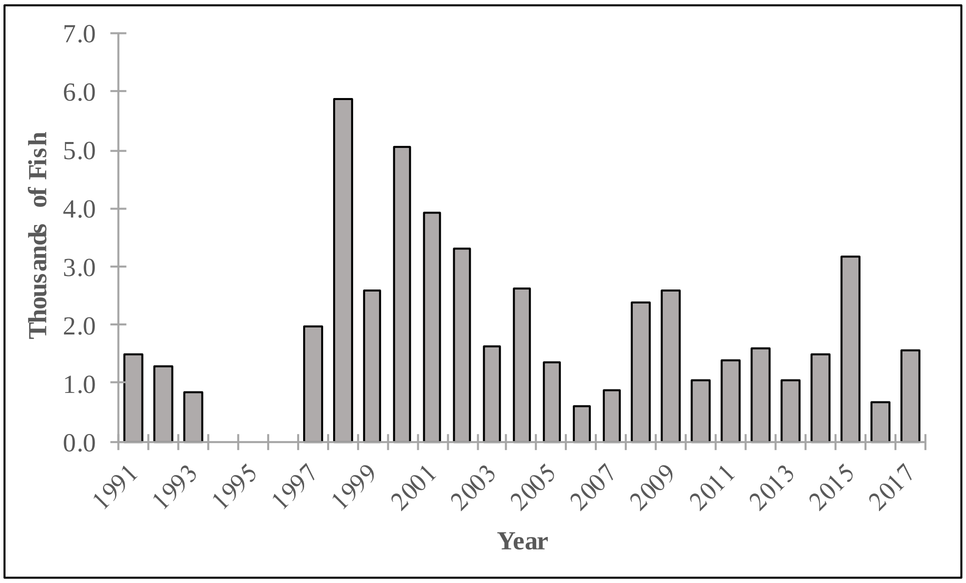

Figure 2.12. Annual estimates of recreational dead discards for the Albemarle Sound, 1991–2017.

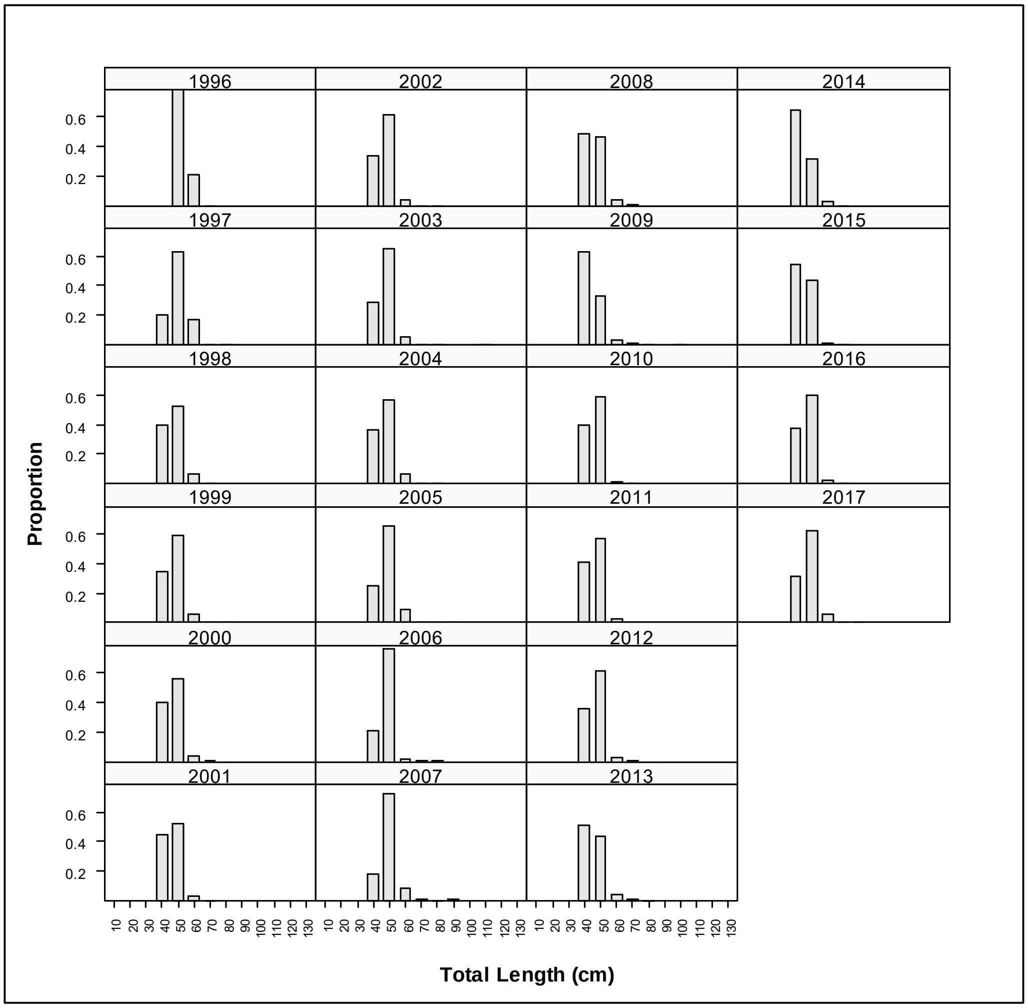

Figure 2.13. Annual length frequencies of striped bass recreational harvest in the Albemarle Sound, 1996–2017.

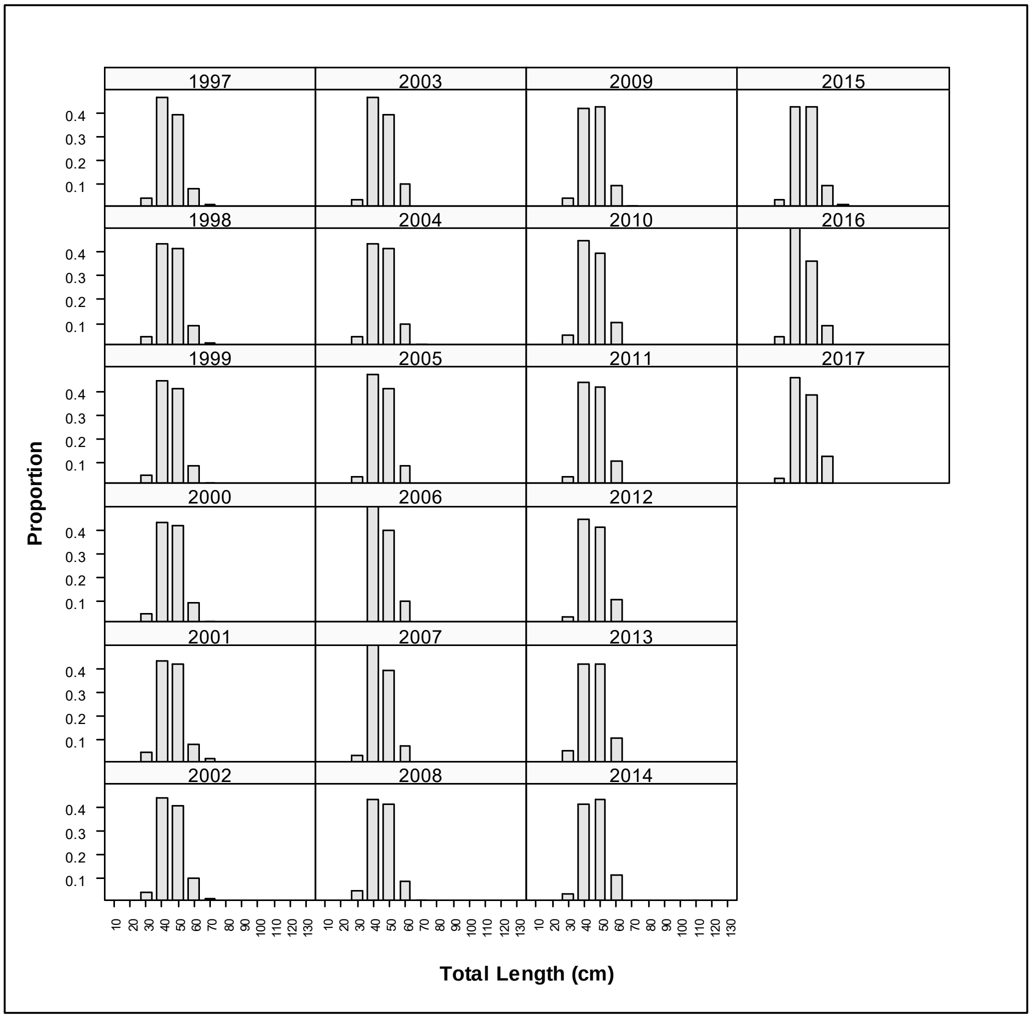

Figure 2.14. Annual length frequencies of striped bass recreational discards in the Albemarle Sound, 1997–2017.

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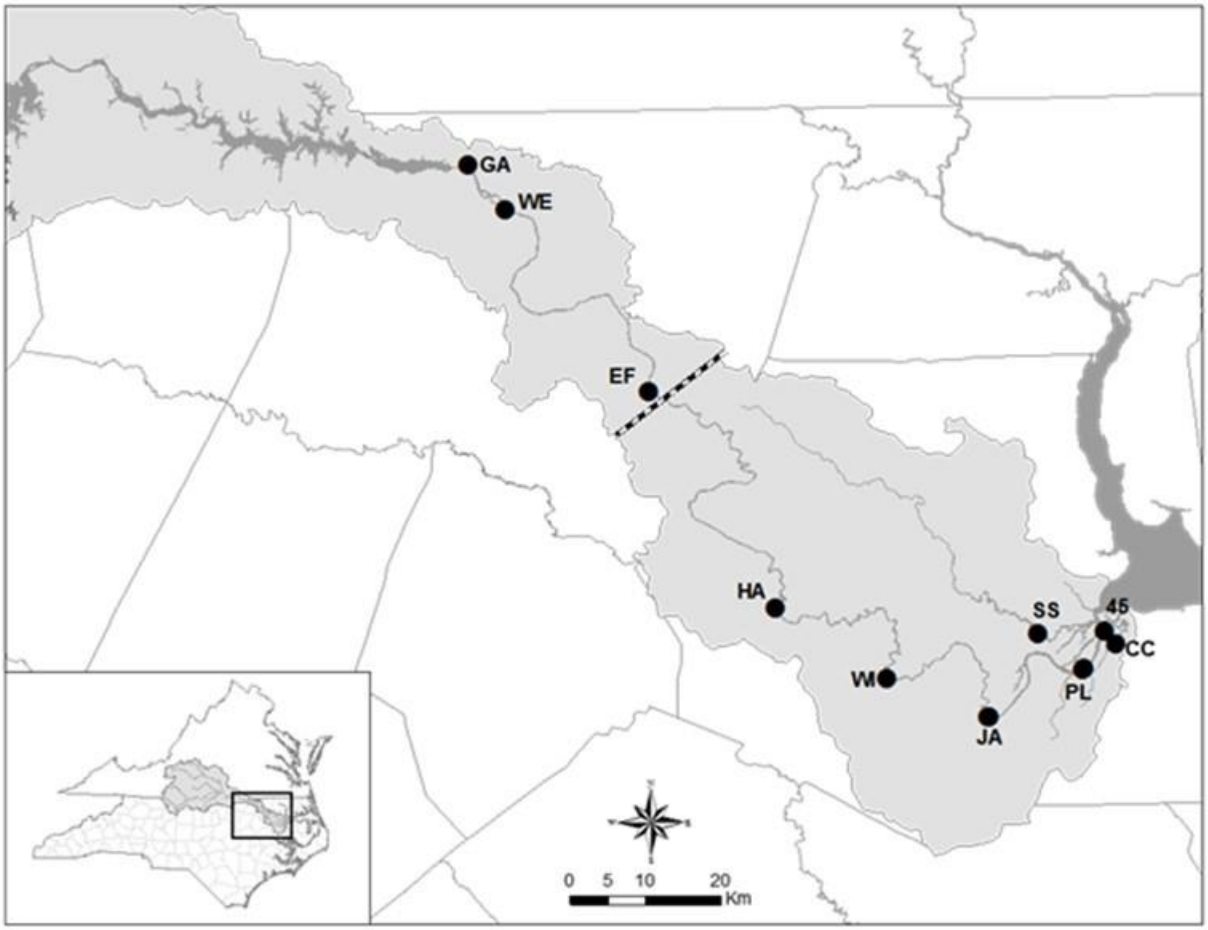

Figure 2.15. Map of angler creel survey interview locations in the RRMA, NC. The dashed line indicates the demarcation point between the upper and lower zones. Zone 1 access areas include (GA) Gaston (US HWY 48), (WE) Weldon, and (EF) Scotland Neck (Edwards Ferry US HWY 258). Zone 2 access areas include (HA) Hamilton, (WI) Williamston, (JA) Jamesville, (PL) Plymouth, (45) US HWY 45, (CC) Conaby Creek, and (SS) Sans Souci (Cashie River).

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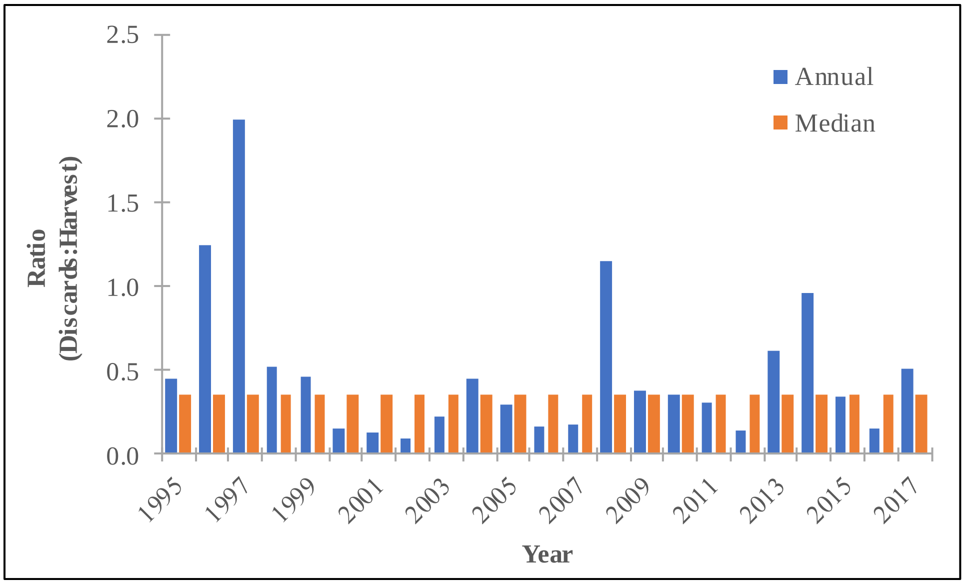

Figure 2.16. Ratio of recreational dead discards to recreational harvest in the Roanoke River, 1995–2017.

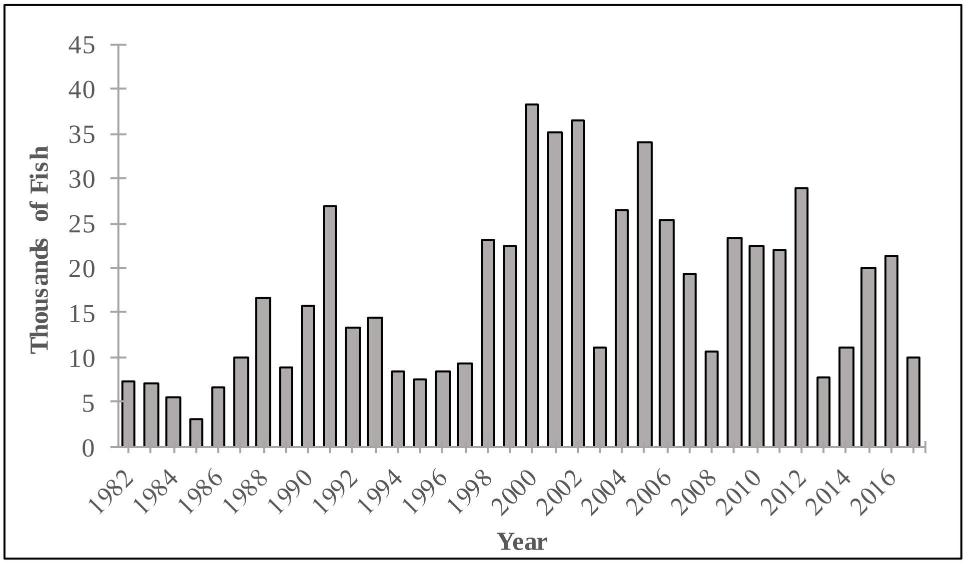

Figure 2.17. Annual estimates of recreational harvest for the Roanoke River, 1982–2017.

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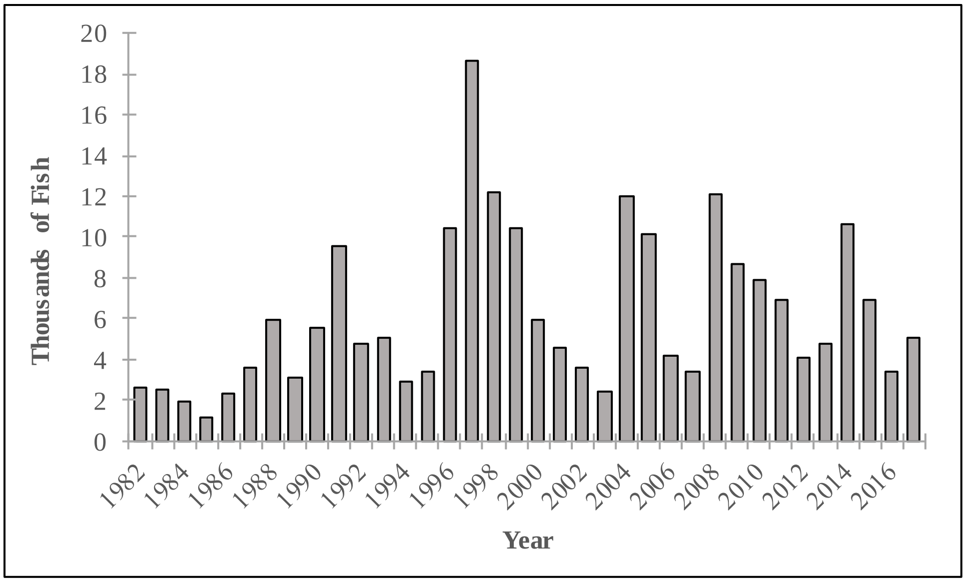

Figure 2.18. Annual estimates of recreational dead discards for the Roanoke River, 1982–2017. Note that discard values prior to 1995 were estimated using a hindcasting approach.

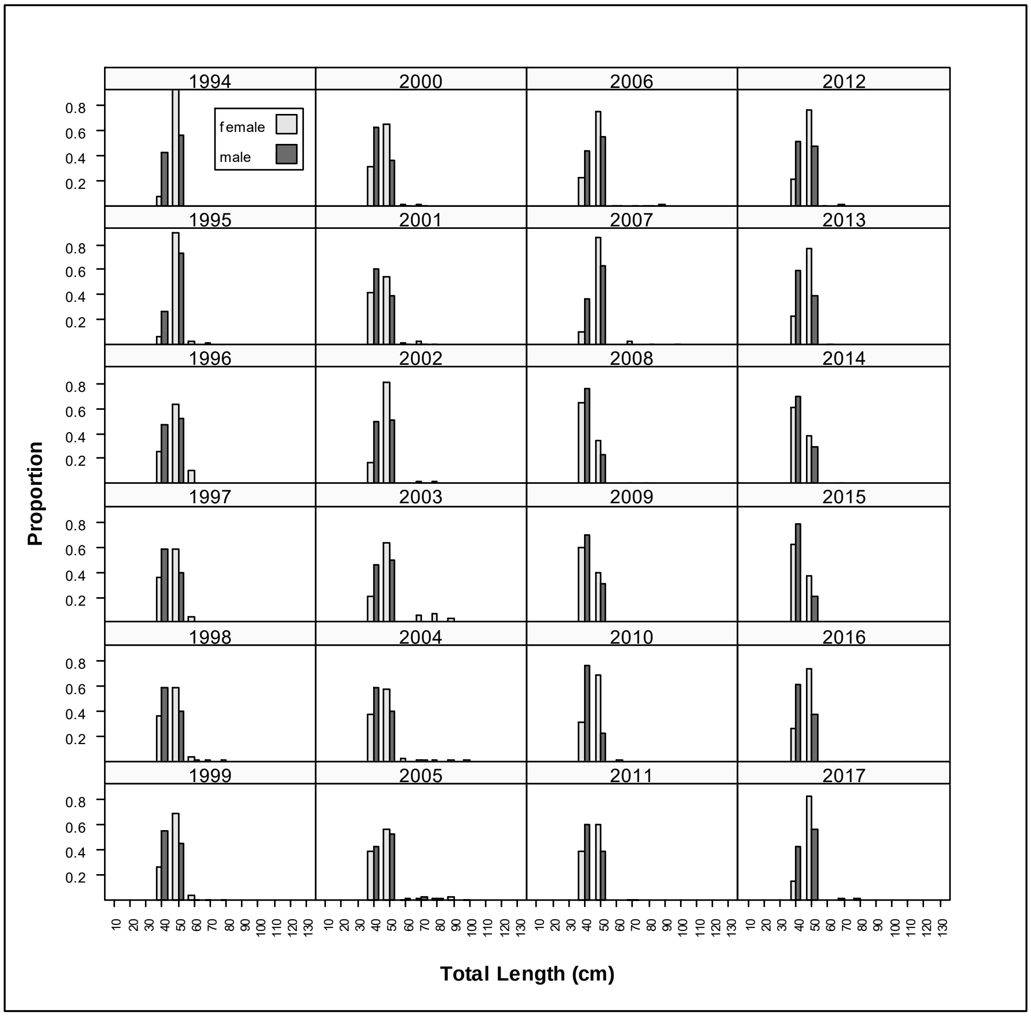

Figure 2.19. Annual length frequencies of striped bass recreational harvest in the Roanoke River, 1994–2017.

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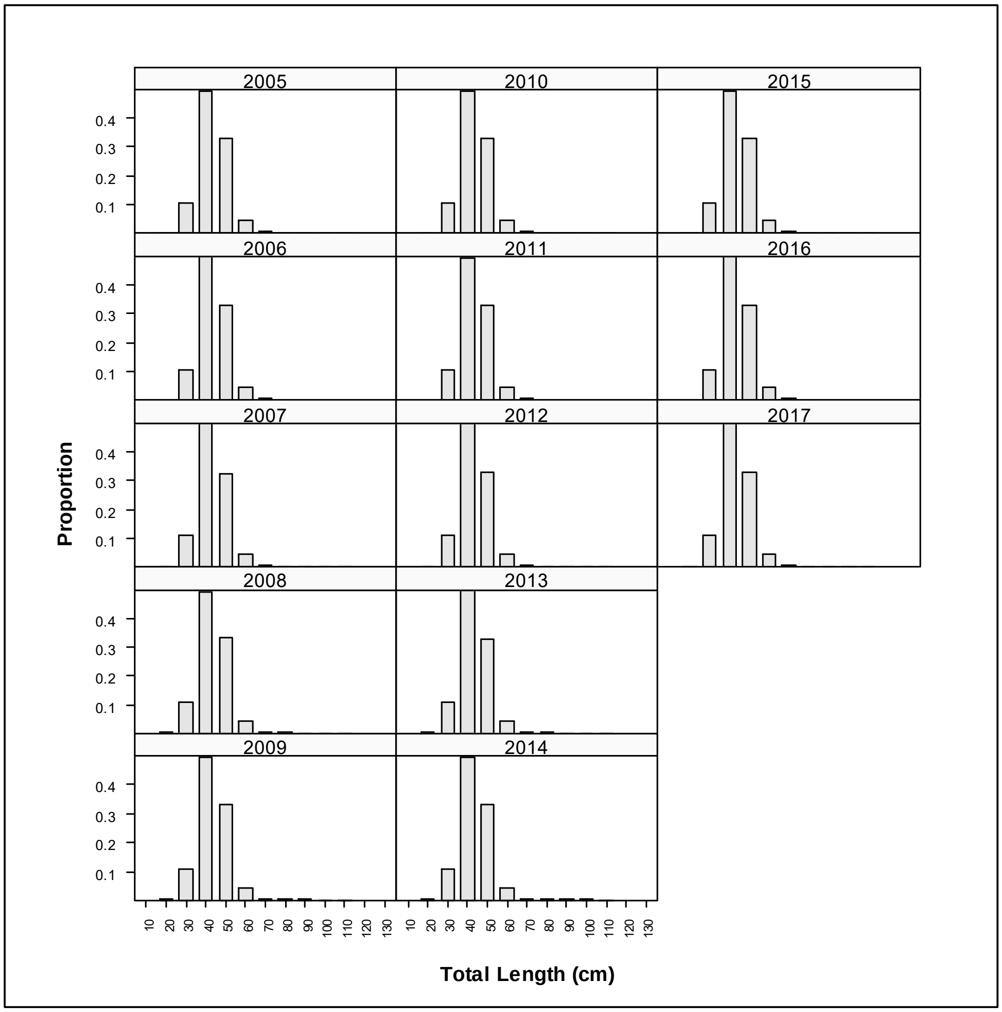

Figure 2.20. Annual length frequencies of striped bass recreational discards in the Roanoke River, 2005–2017.

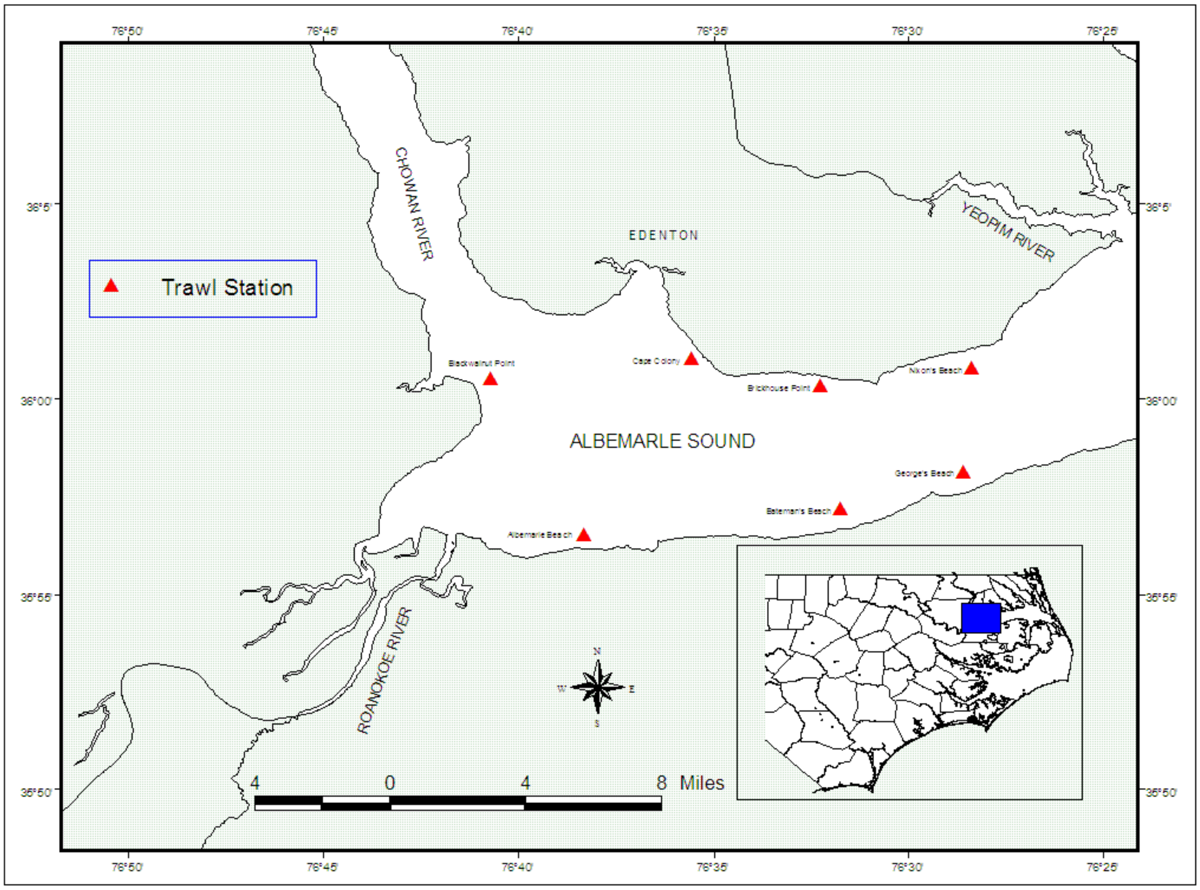

Figure 2.21. Map of NCDMF Juvenile Abundance Survey (Program 100) sampling sites.

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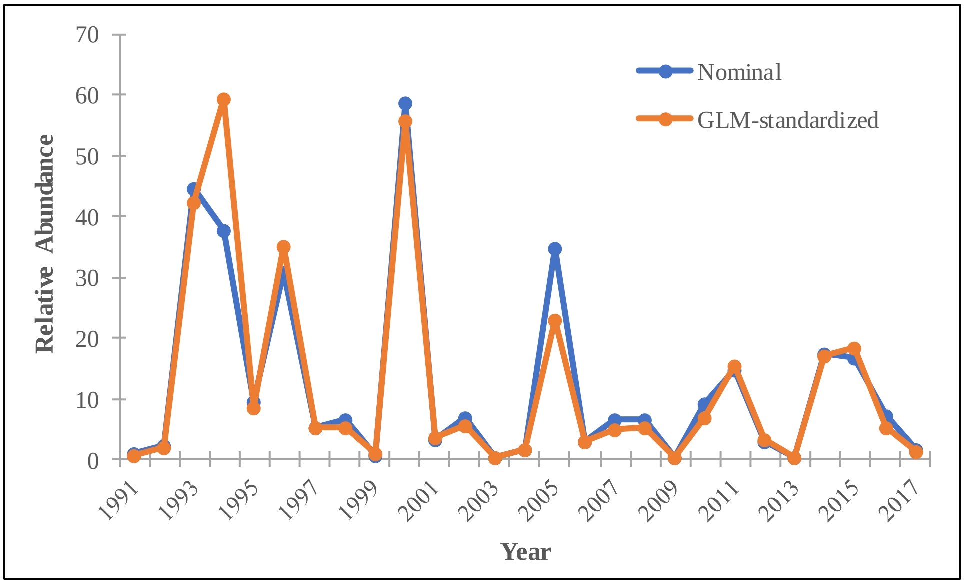

Figure 2.22. Nominal and GLM-standardized indices of relative age-0 abundance derived from the Juvenile Abundance Survey (P100), 1991–2017.

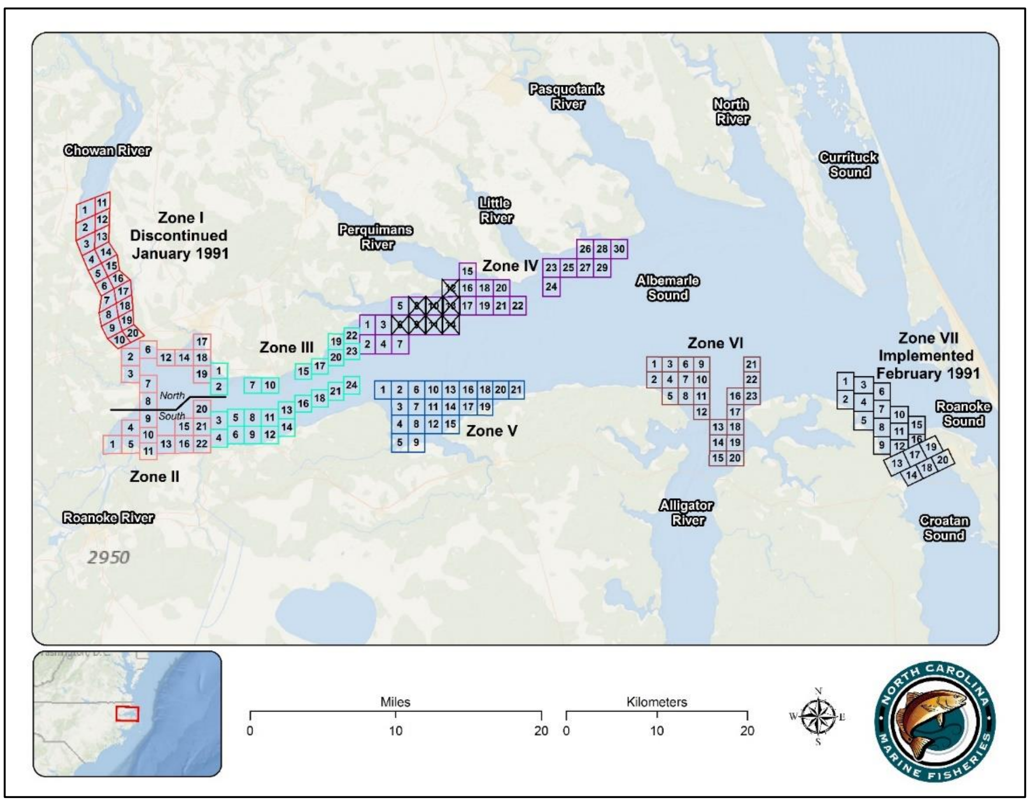

Figure 2.23. Map of sampling grids and zones for the NCDMF Independent Gill-Net Survey (Program 135).

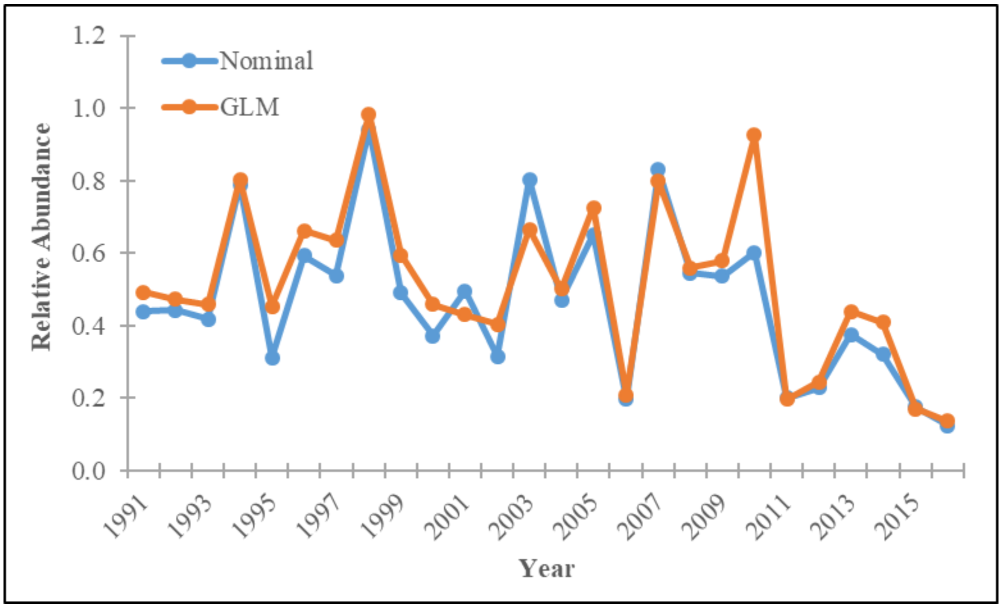

Figure 2.24. Nominal and GLM-standardized indices of relative abundance derived from the fall/winter component of the NCDMF Independent Gill-Net Survey (P135), 1991–2016.

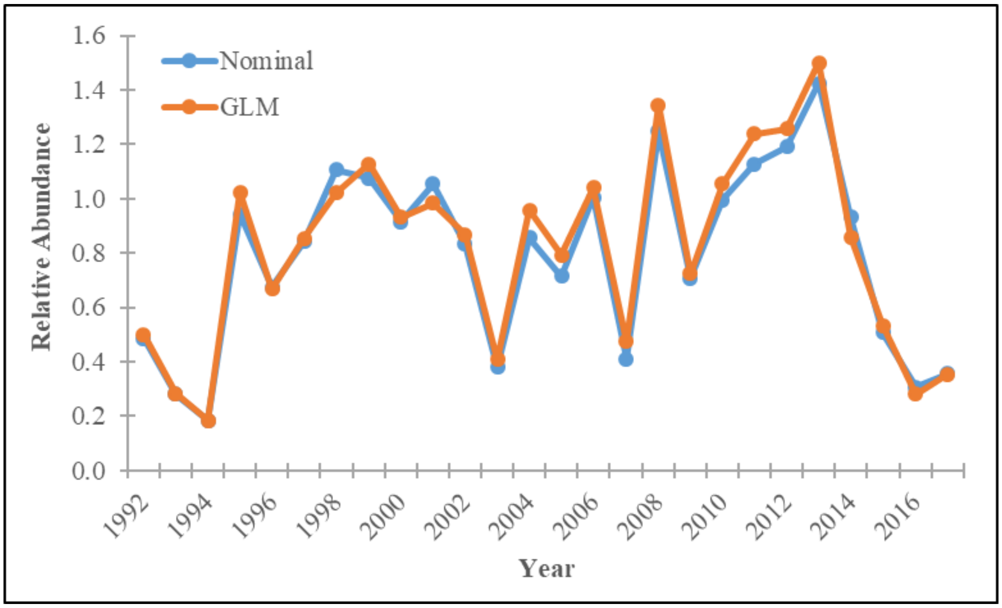

Figure 2.25. Nominal and GLM-standardized indices of relative abundance derived from the spring component of the NCDMF Independent Gill-Net Survey (P135), 1992–2017.

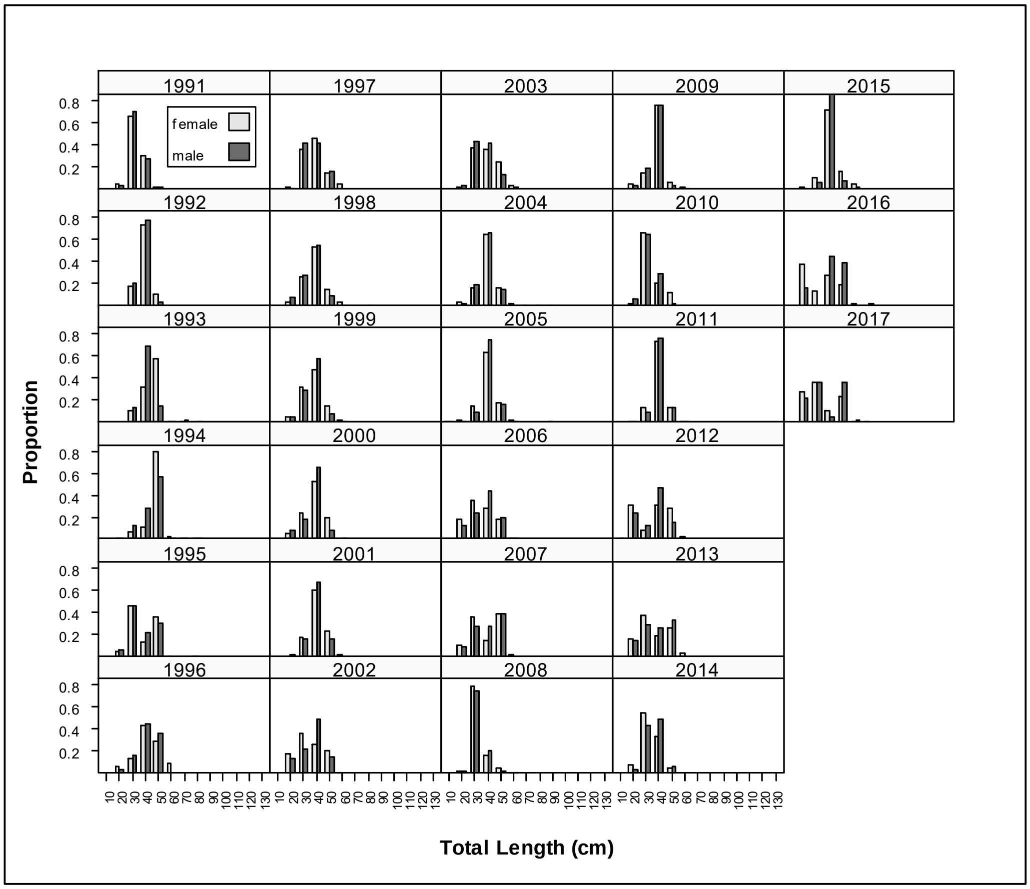

Figure 2.26. Annual length frequencies of striped bass sampled from the fall/winter component of the NCDMF Independent Gill-Net Survey (P135), 1991–2017.

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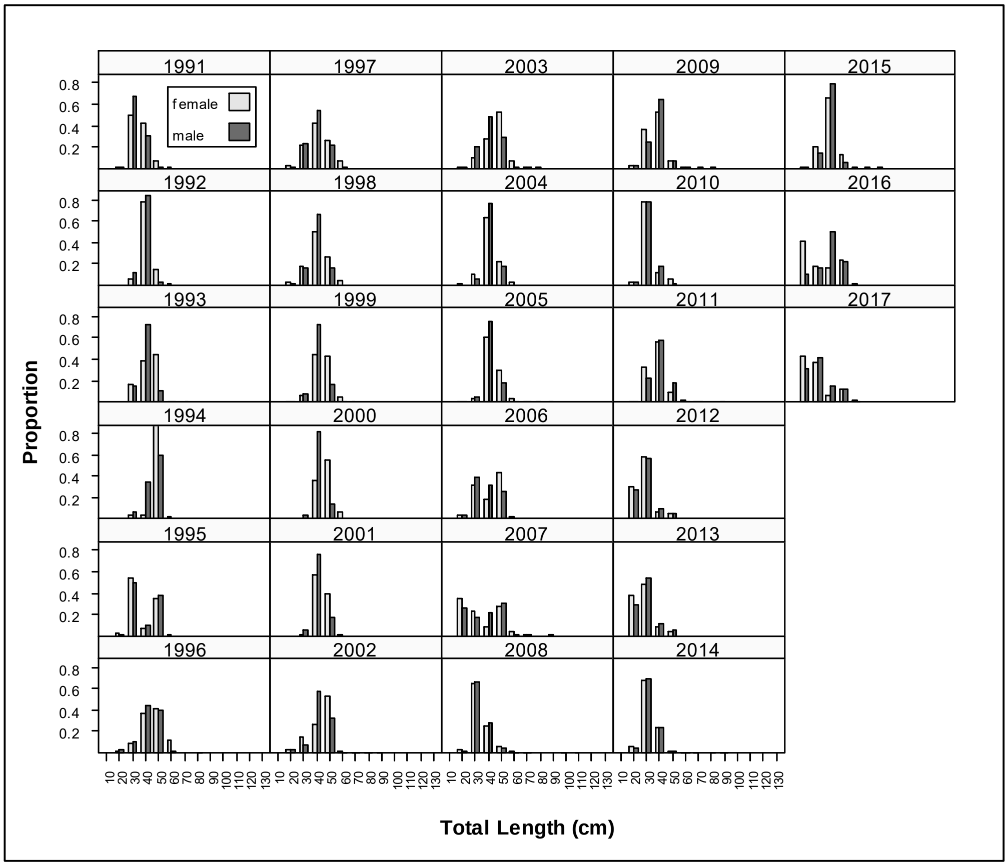

Figure 2.27. Annual length frequencies of striped bass sampled from the spring component of the NCDMF Independent Gill-Net Survey (P135), 1991–2017.

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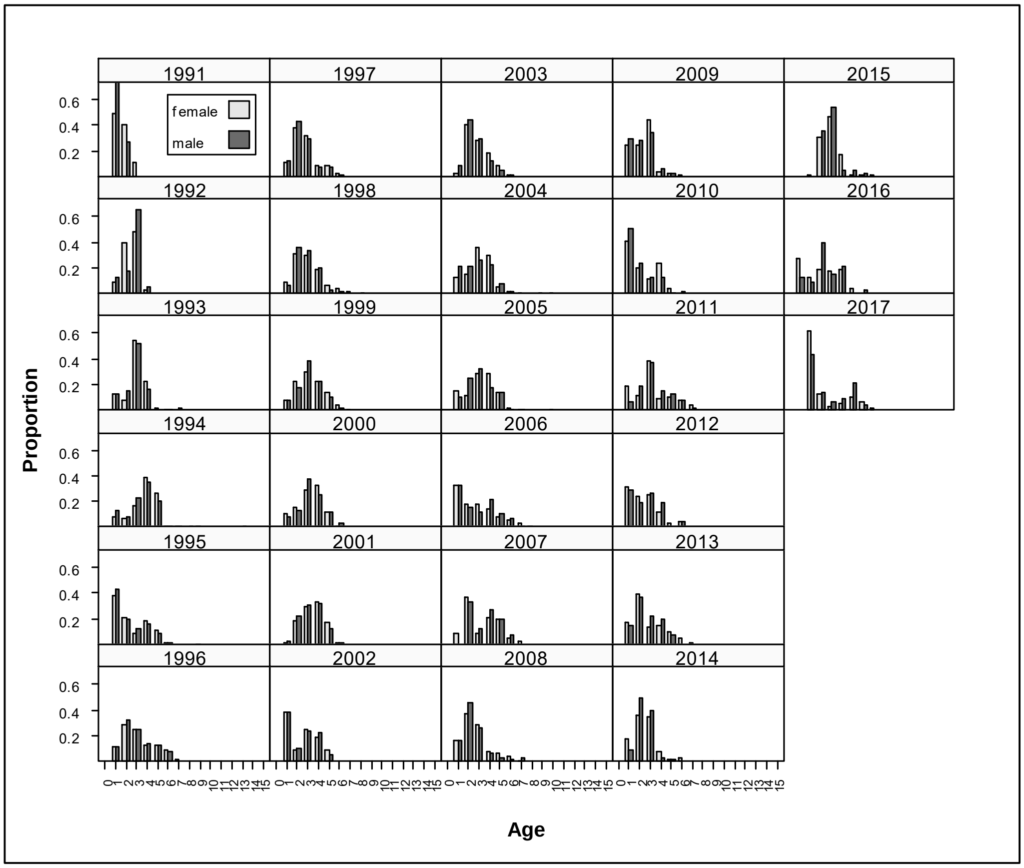

Figure 2.28. Annual age frequencies of striped bass sampled from the fall/winter component of the NCDMF Independent Gill-Net Survey (P135), 1991–2017. Thea age-15 bin represents a plus group.

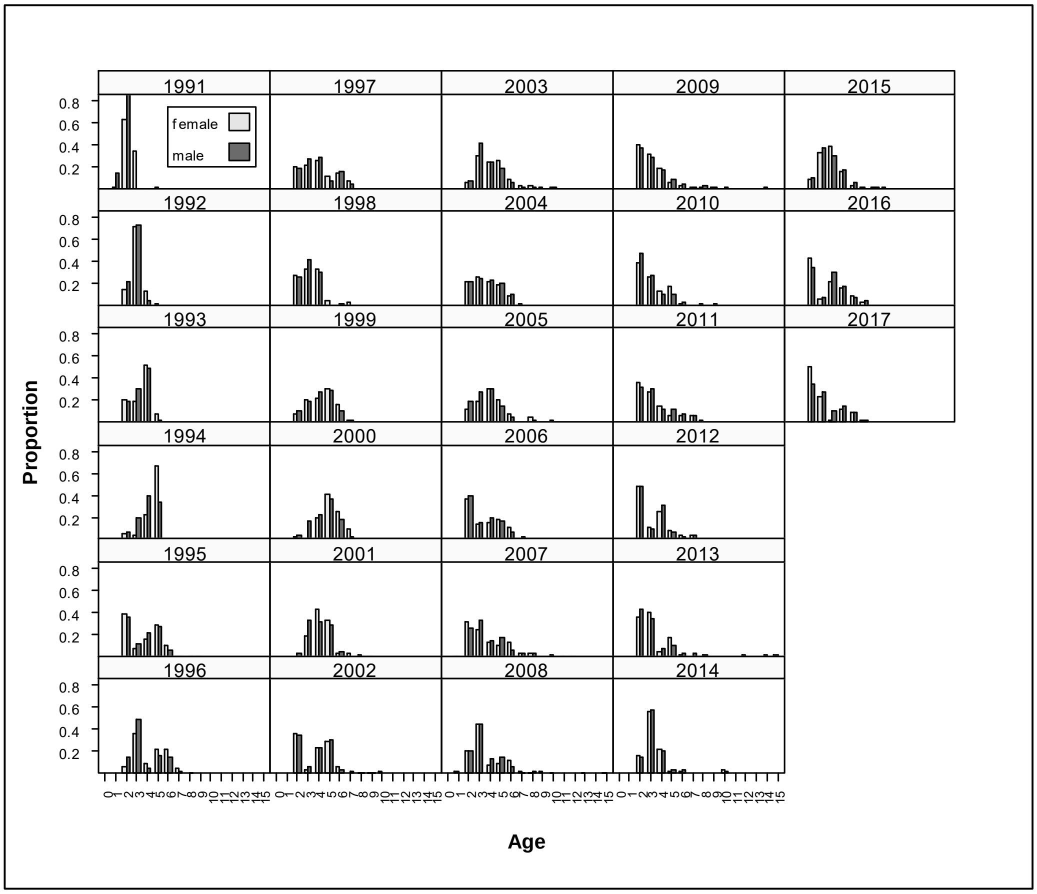

Figure 2.29. Annual age frequencies of striped bass sampled from the spring component of the NCDMF Independent Gill-Net Survey (P135), 1991–2017. The age-15 bin represents a plus group.

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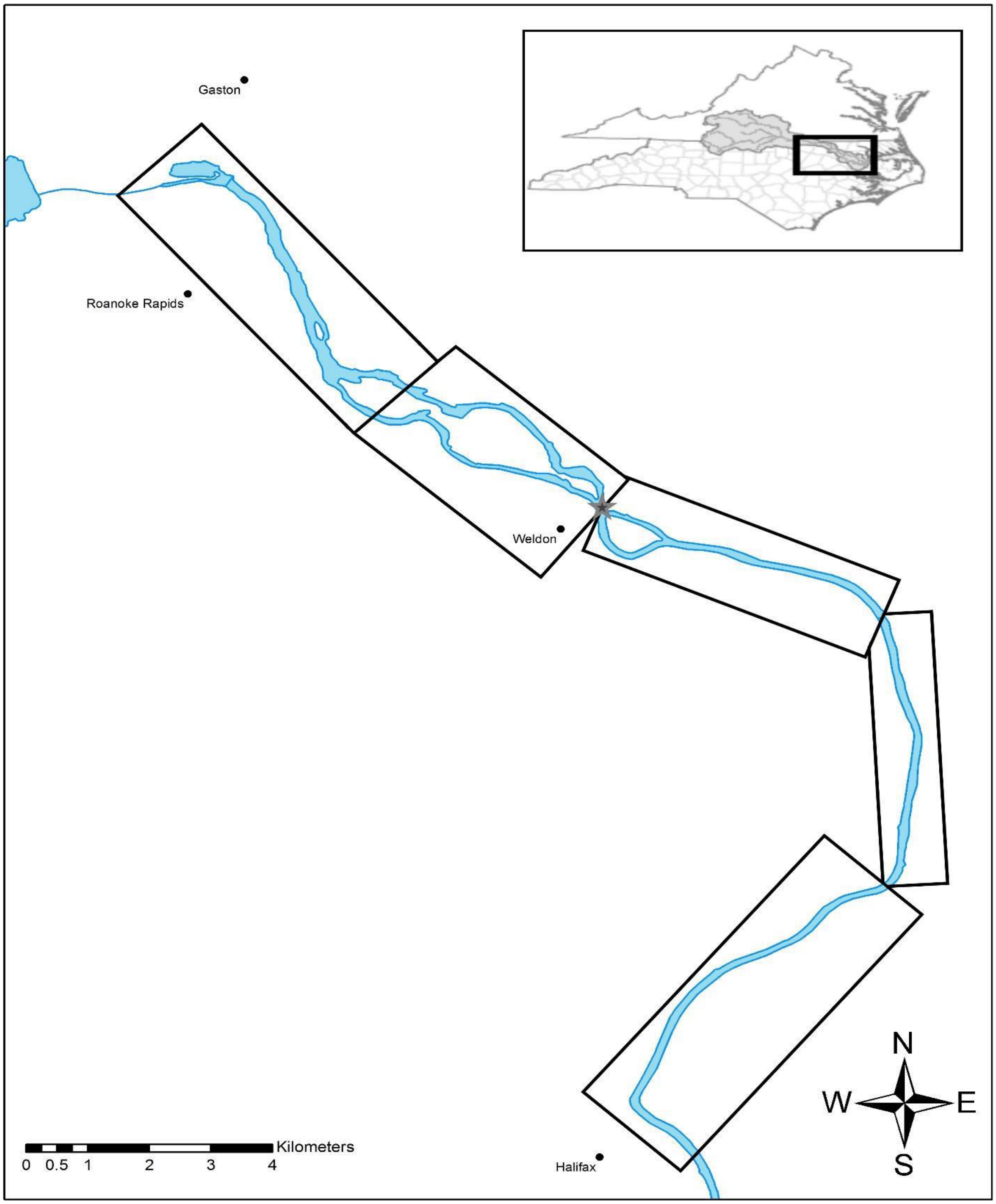

Figure 2.30. Striped Bass spawning grounds on the Roanoke River, near the vicinity of Weldon, North Carolina. Black boxes represent relative locations of river strata. The gray star indicates location of rapids near the Weldon boating access area; flows less than 7,000 cfs restrict access to the strata above this location.

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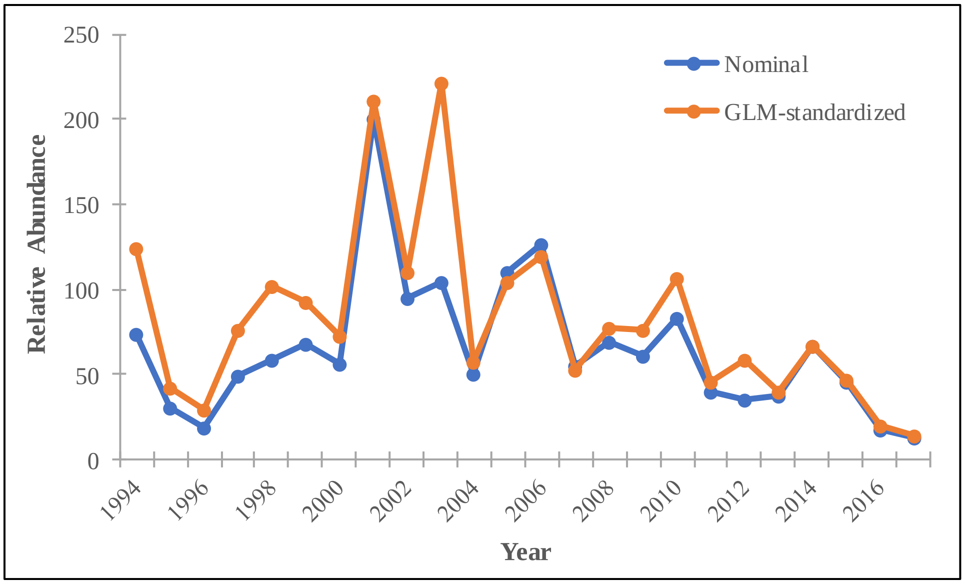

Figure 2.31. Nominal and GLM-standardized indices of relative abundance derived from the NCWRC Roanoke River Electrofishing Survey, 1994–2017.

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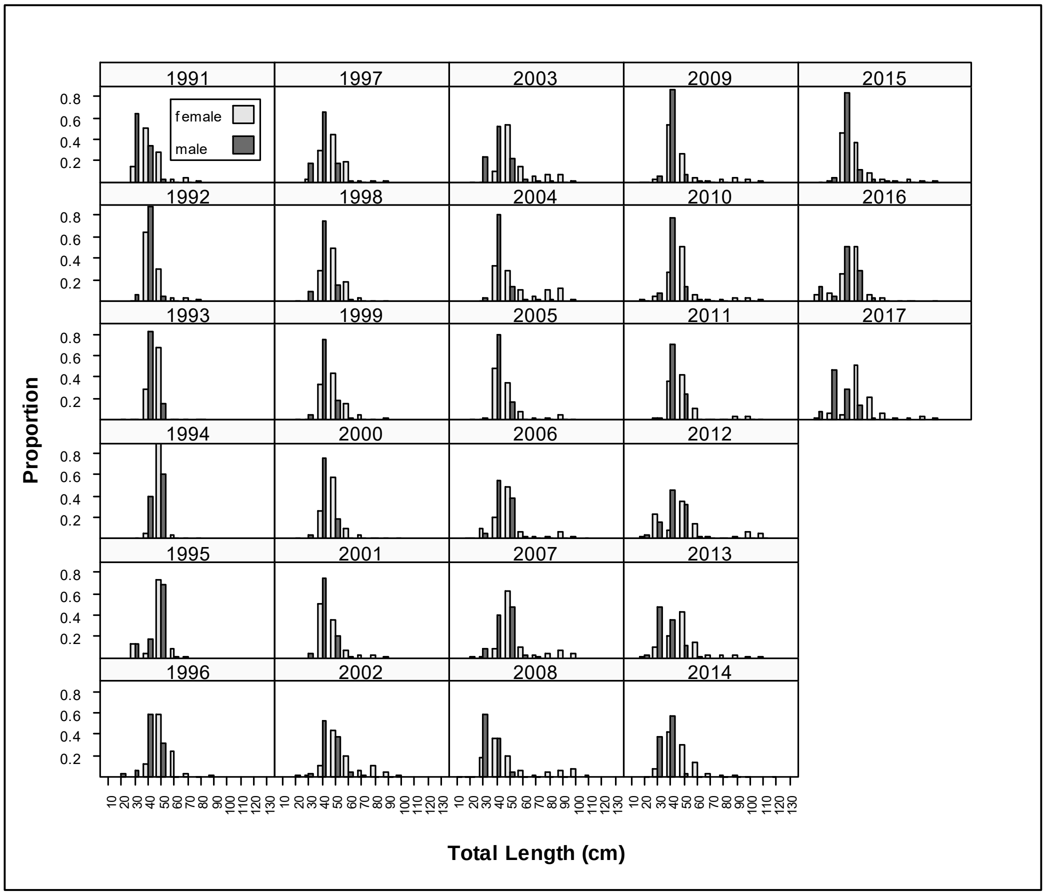

Figure 2.32. Annual length frequencies of striped bass sampled from the NCWRC Roanoke River Electrofishing Survey, 1991–2017.

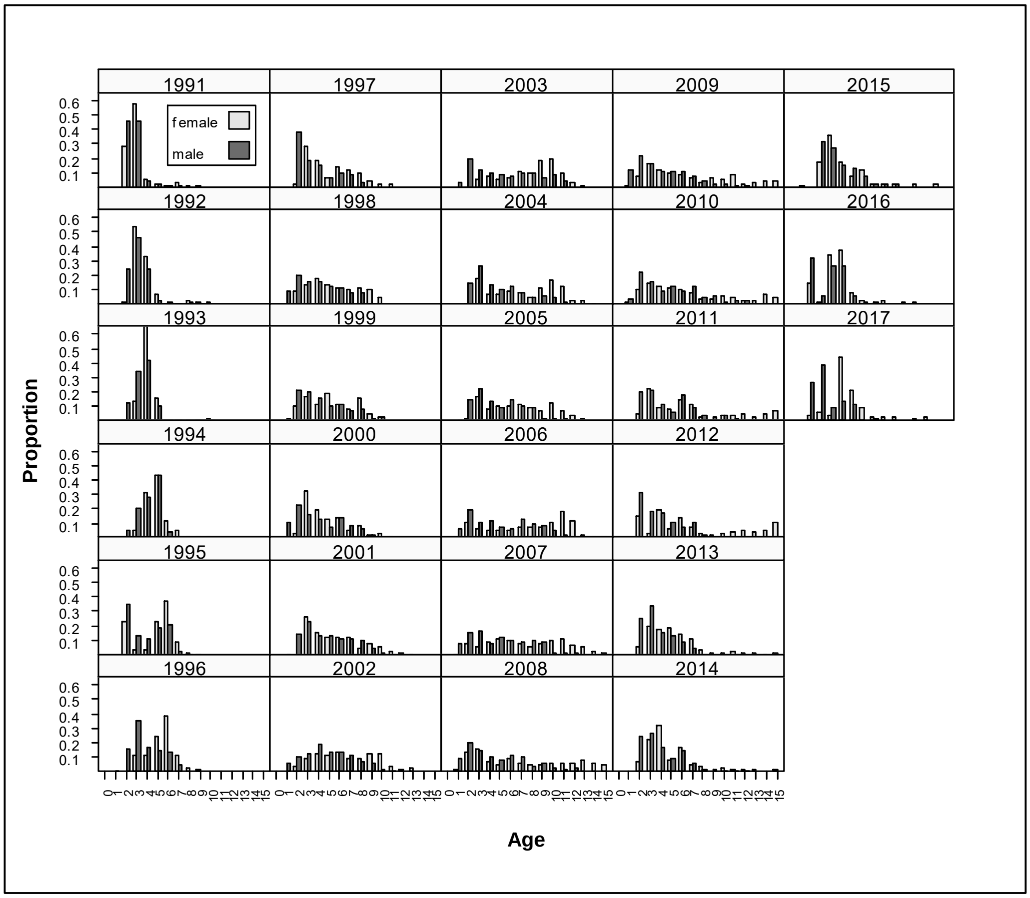

Figure 2.33. Annual age frequencies of striped bass sampled from the NCWRC Roanoke River Electrofishing Survey, 1991–2017. The age-15 bin represents a plus group.

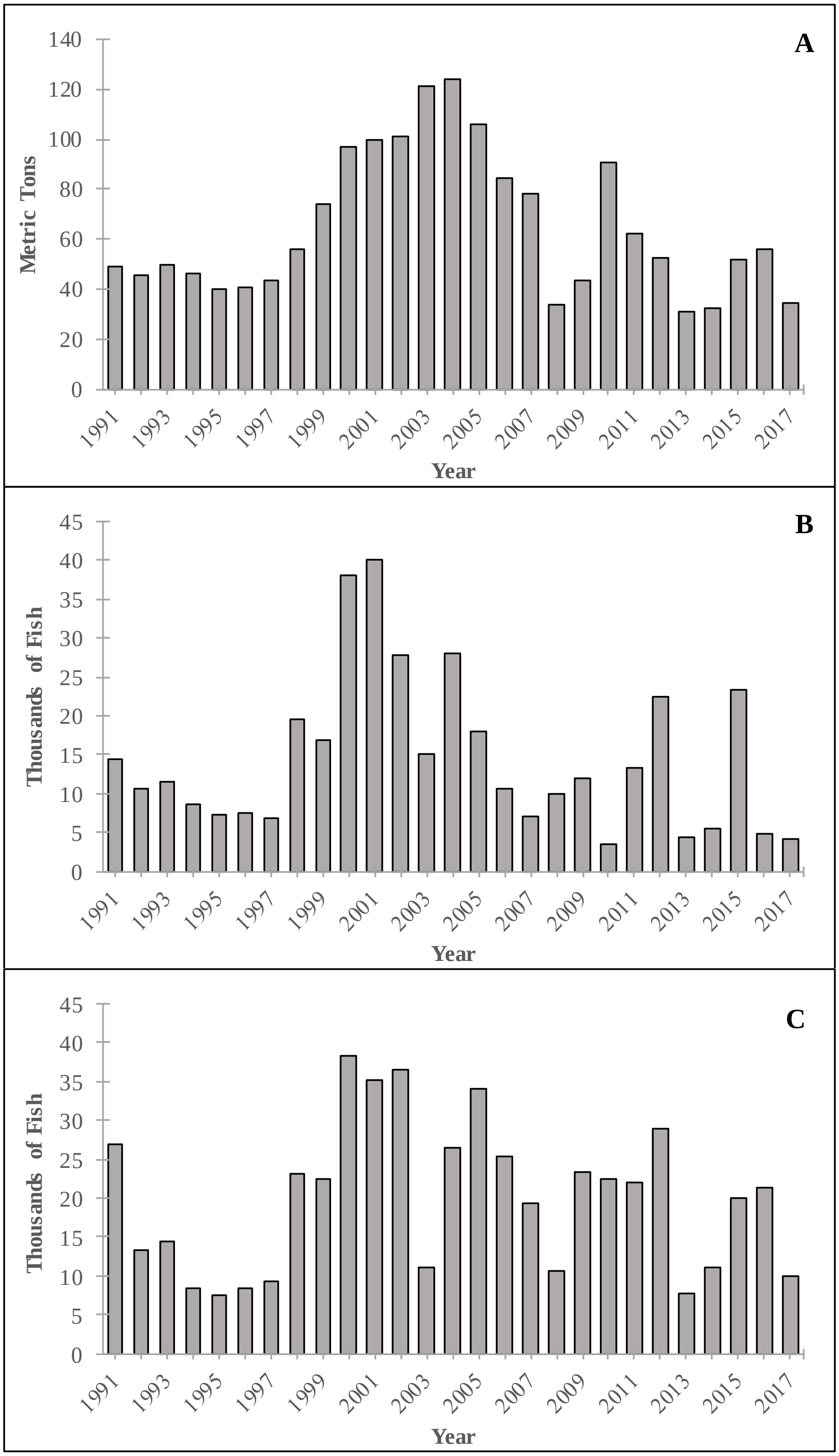

Figure 3.1. Annual (A) ARcomm landings, (B) ASrec harvest, and (C) RRrec harvest values that were input into the SS model, 1991–2017.

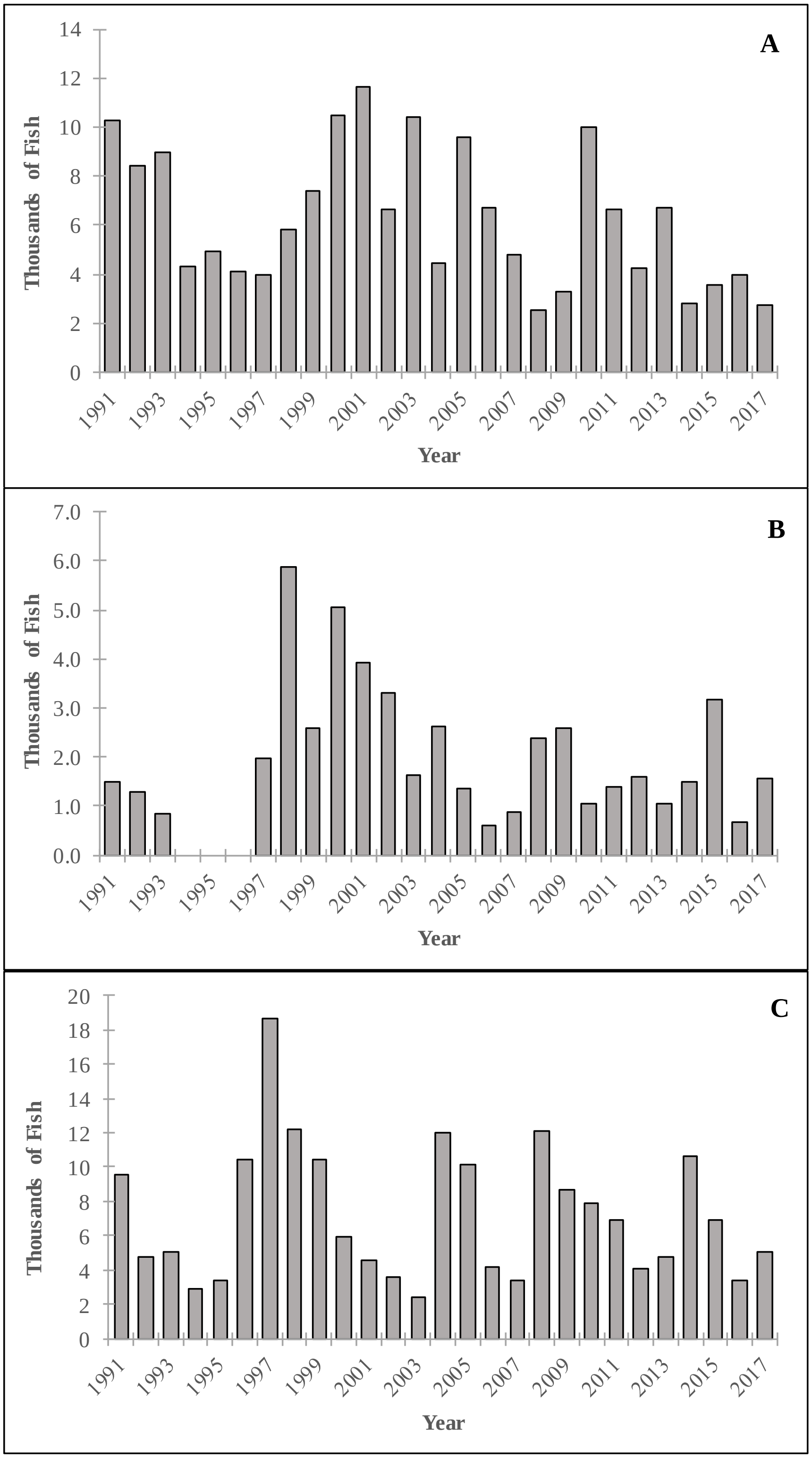

Figure 3.2. Annual (A) ARcomm, (B) ASrec, and (C) RRrec dead discards that were input into the SS model, 1991–2017.

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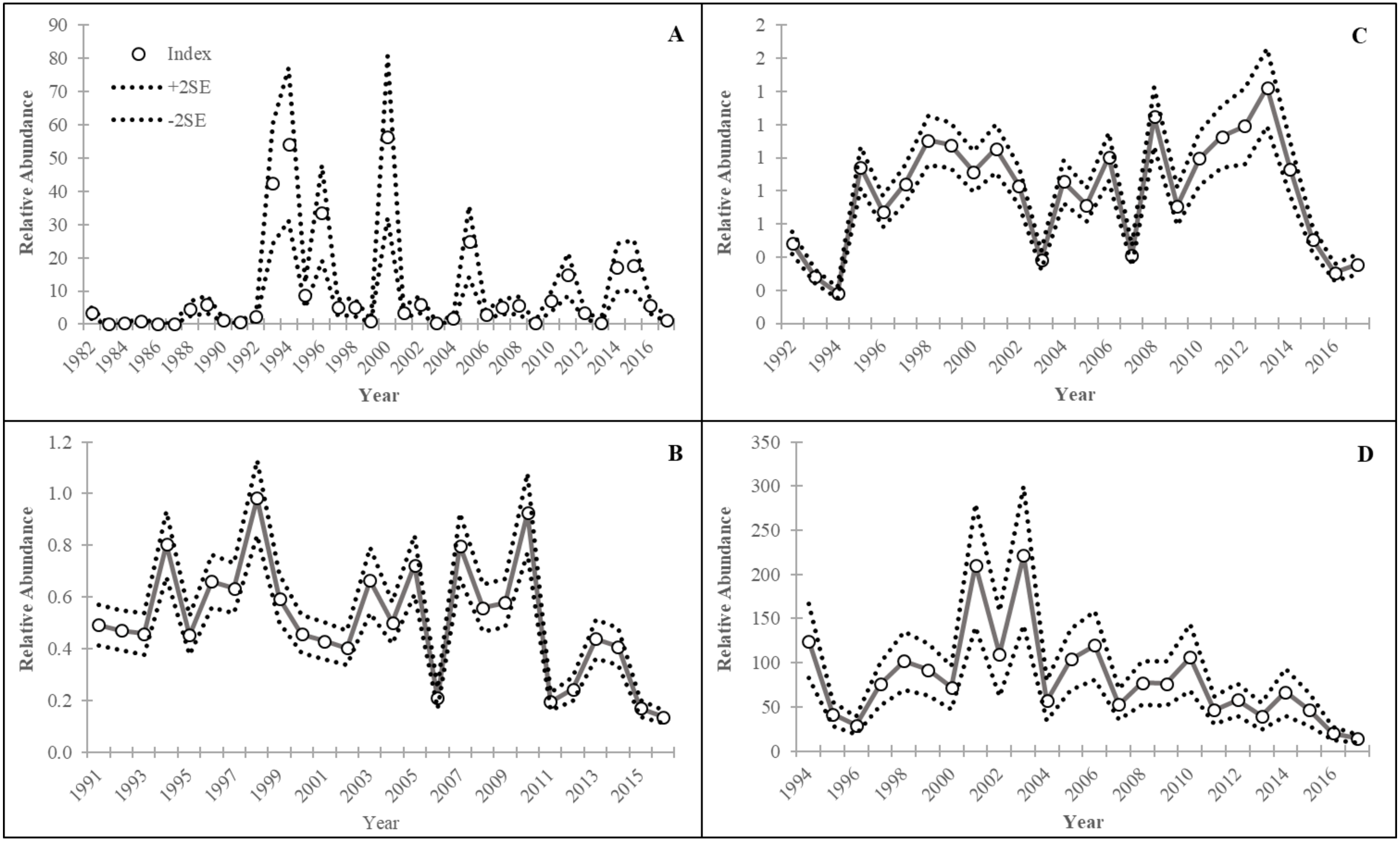

Figure 3.3. GLM-standardized indices of abundance derived from the (A) P100juv, (B) P135fw, (C) P135spr, and (D) RRef surveys that were input into the SS model, 1991–2017.

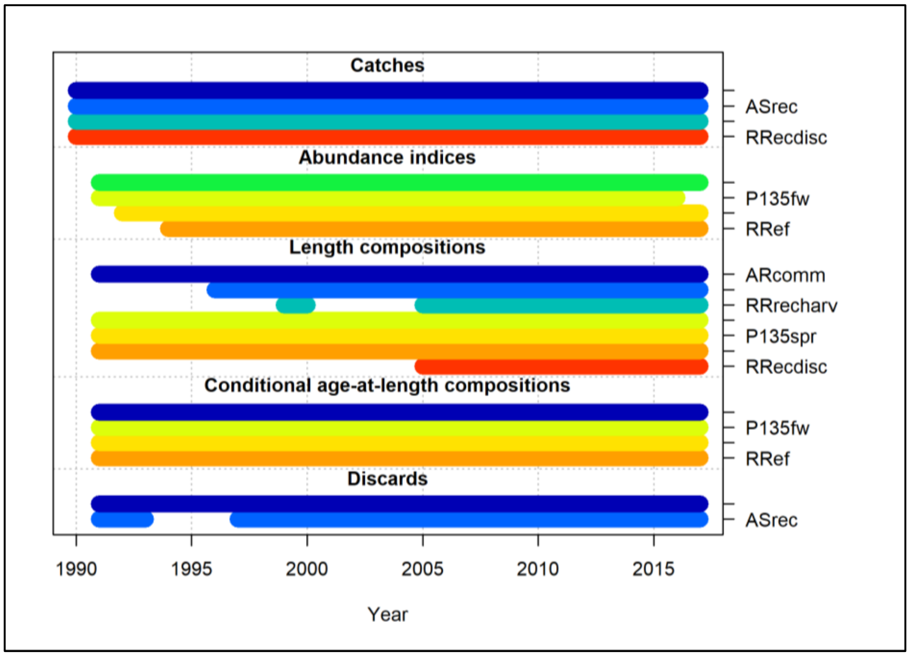

Figure 3.4. Summary of the data sources and types used in the stock assessment model for striped bass.

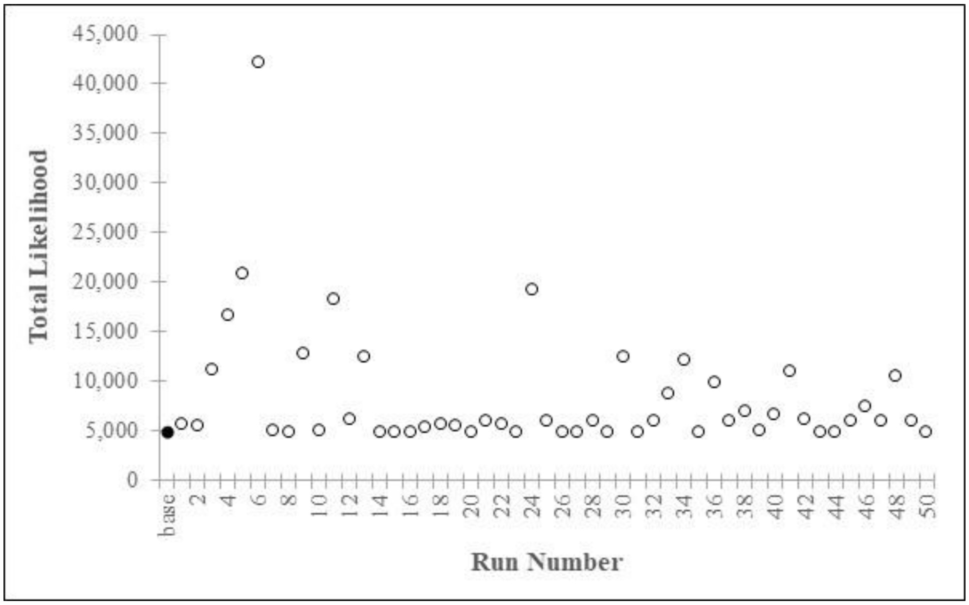

Figure 3.5. Negative log-likelihood values produced from the 50 jitter trials in which initial parameter values were jittered by 10%. The solid black circle is the value from the base run.

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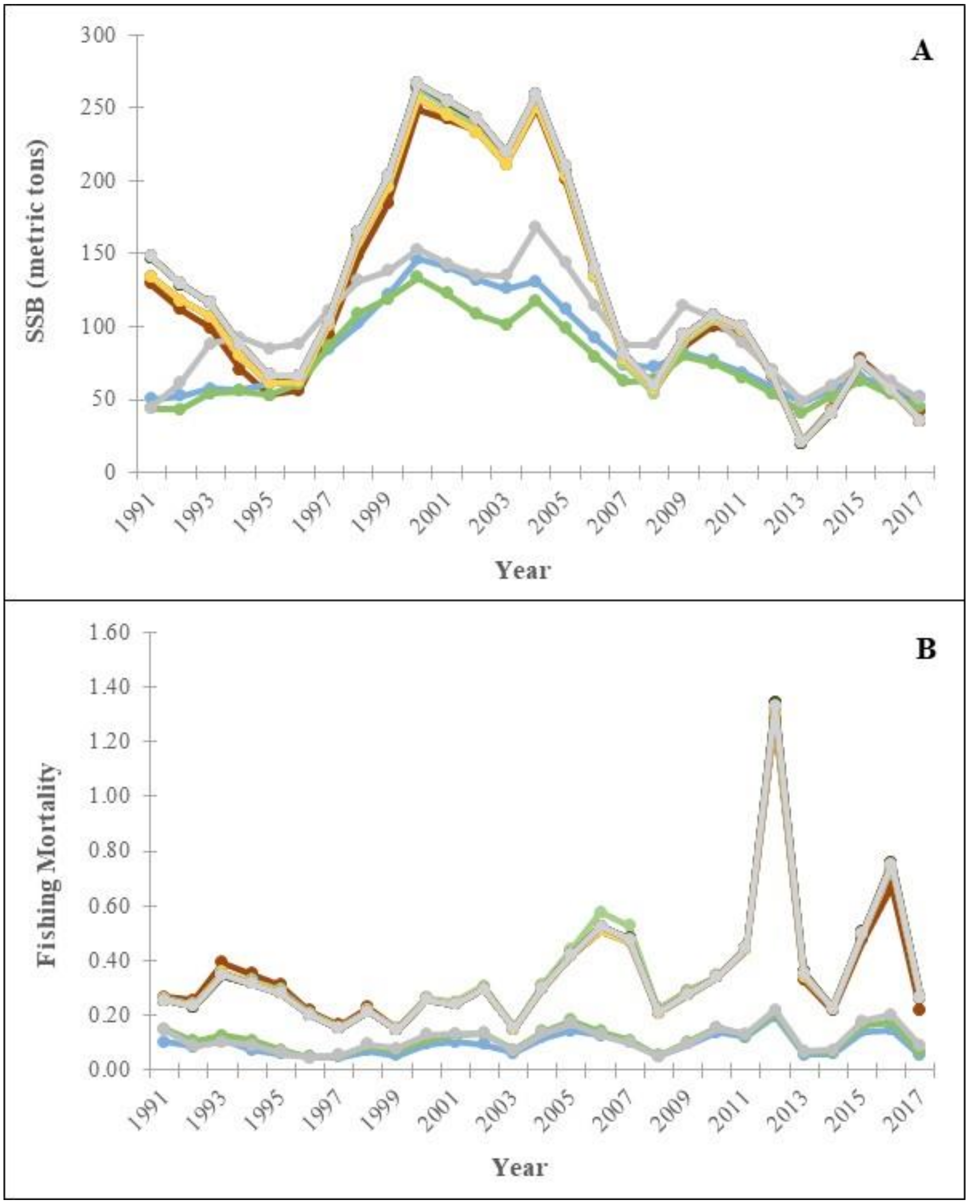

Figure 3.6. Predicted (A) female SSB and (B) *F* (numbers-weighted, ages 3–5) from the converged jitter trials (run 46 removed) in which initial parameter values were jittered by 10%, 1991–2017.

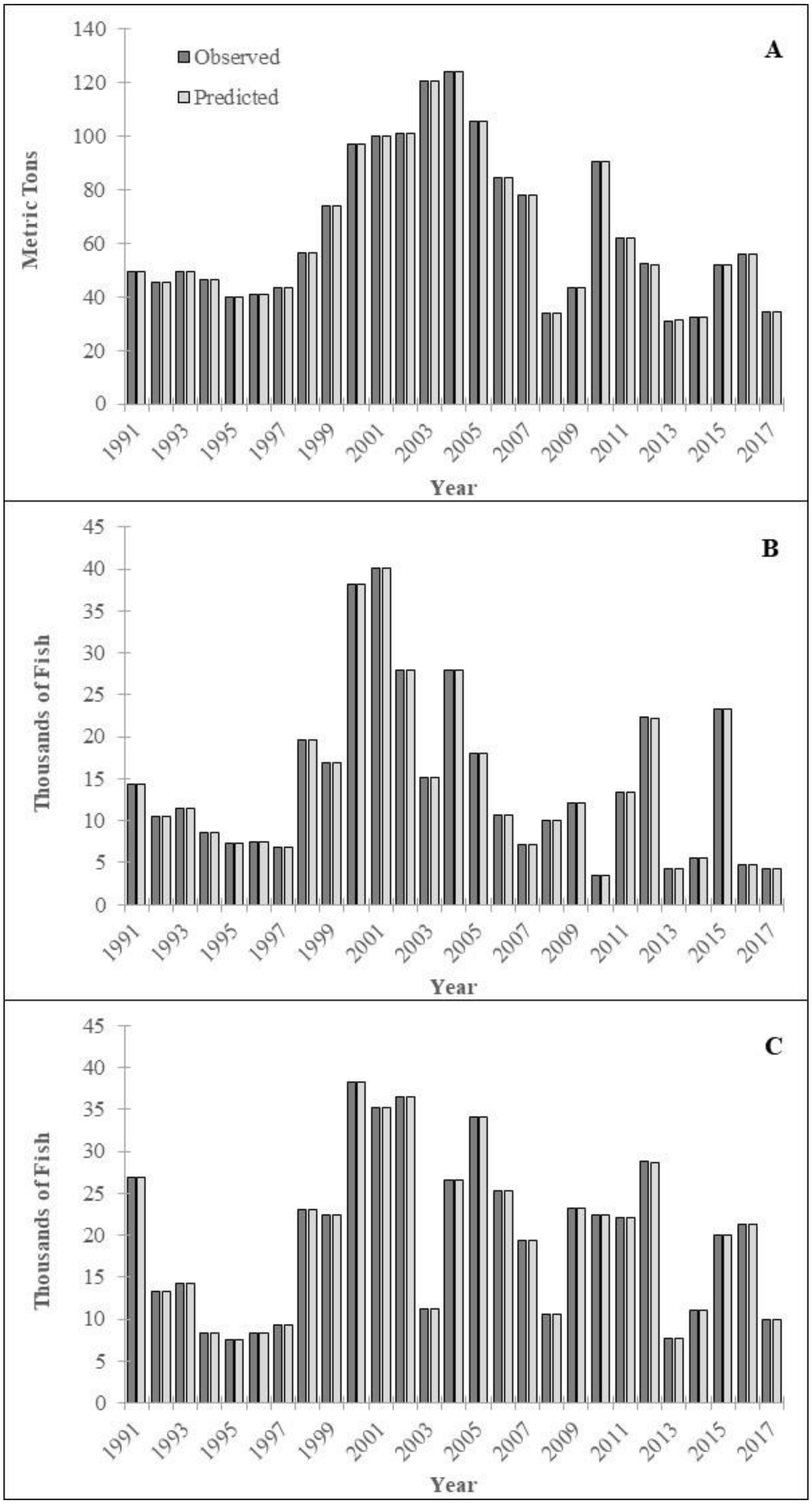

Figure 3.7. Observed and predicted (A) ARcomm landings, (B) ASrec harvest, and (C) RRrec harvest from the base run of the stock assessment model, 1991–2017.

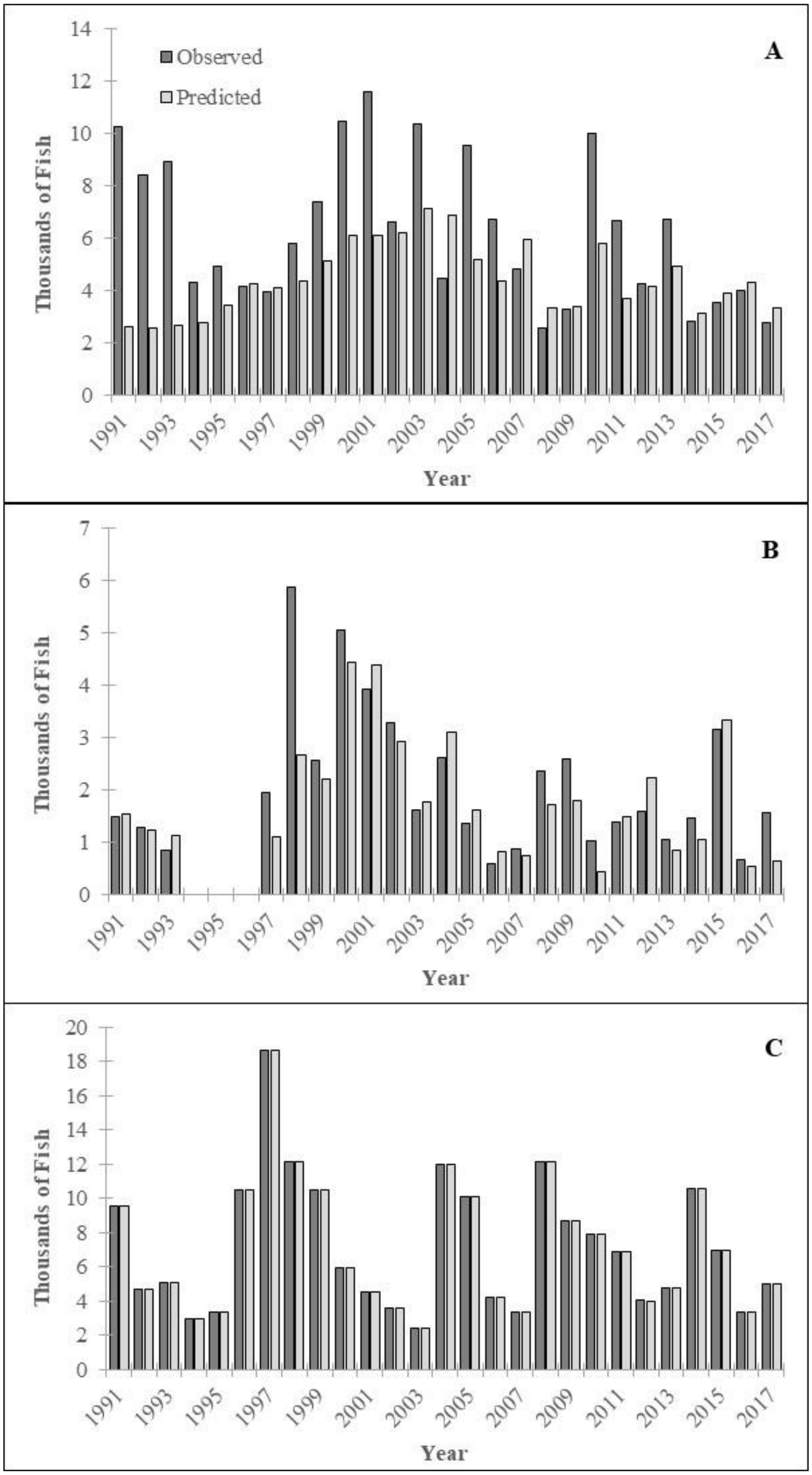

Figure 3.8. Observed and predicted (A) ARcomm, (B) ASrec, and (C) RRrec dead discards from the base run of the stock assessment model, 1991–2017.

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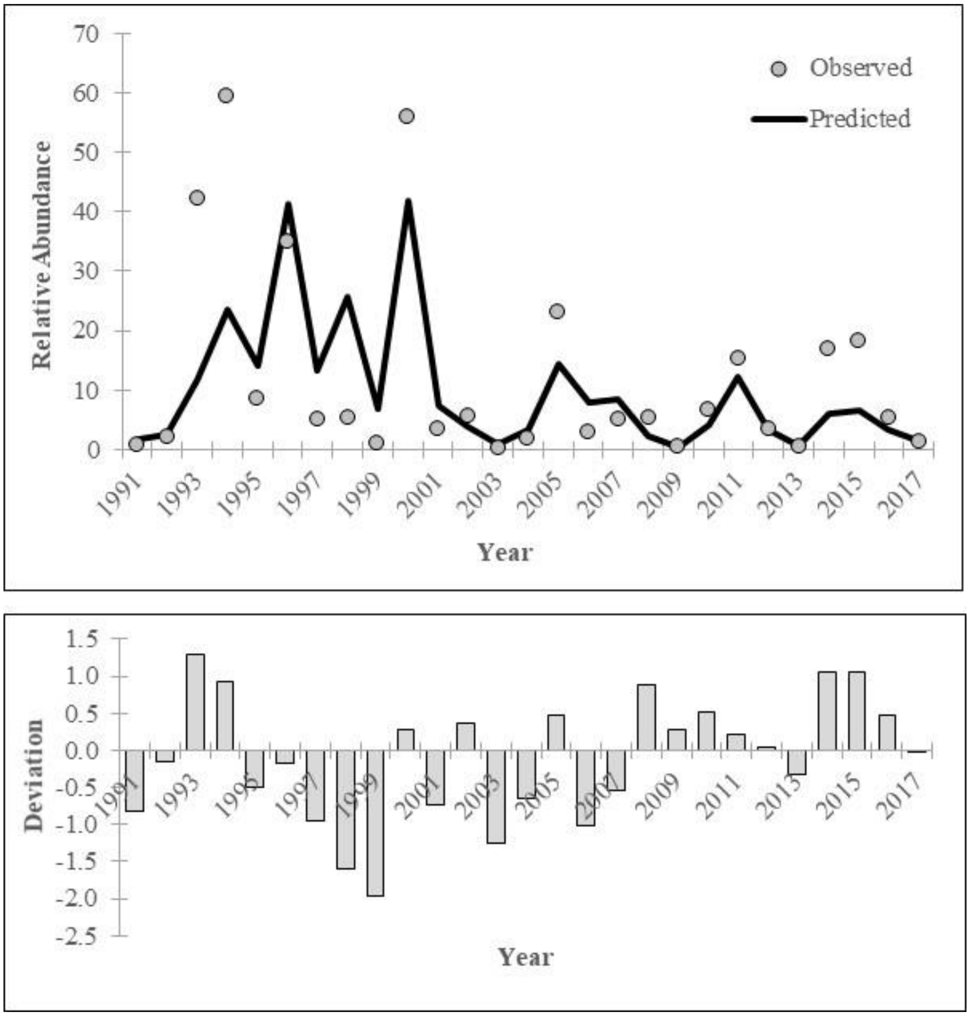

Figure 3.9. Observed and predicted relative abundance (top graph) and standardized residuals (bottom graph) for the P100juv survey from the base run of the stock assessment model, 1991–2017.

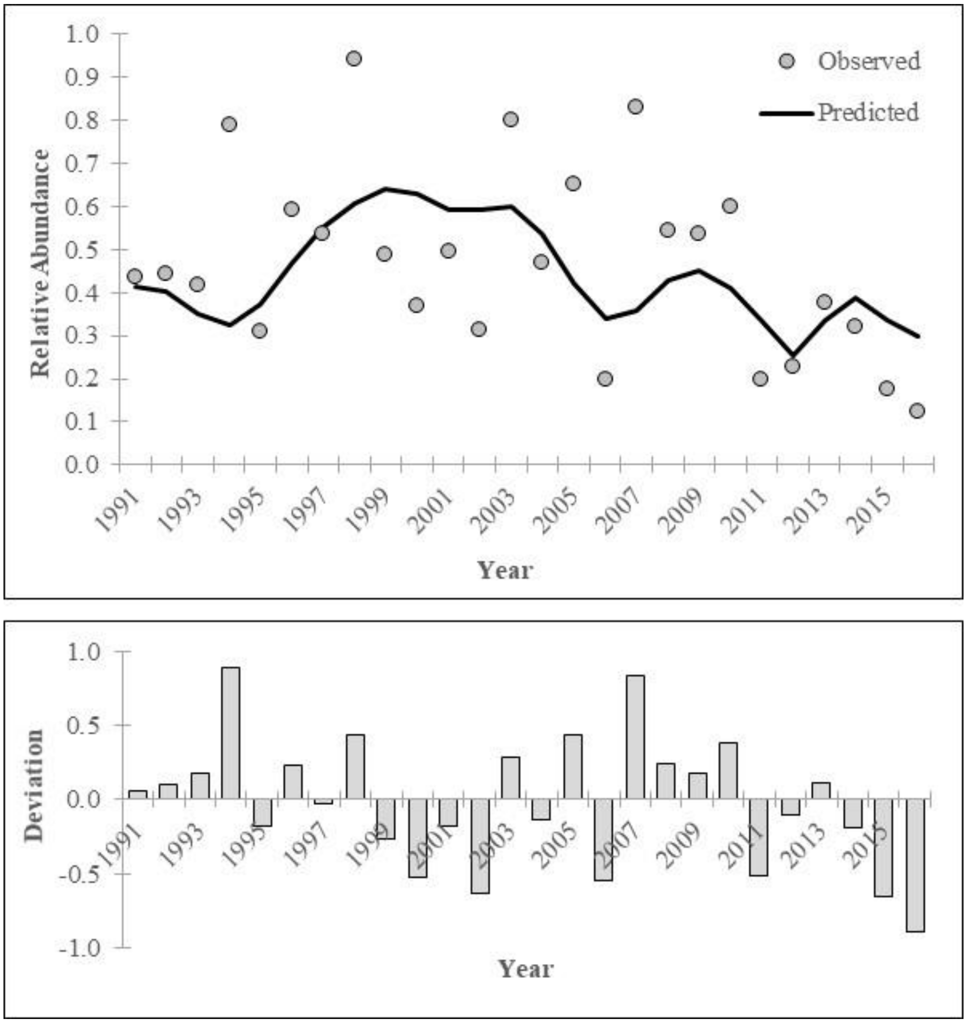

Figure 3.10. Observed and predicted relative abundance (top graph) and standardized residuals (bottom graph) for the P135fw survey from the base run of the stock assessment model, 1991–2017.

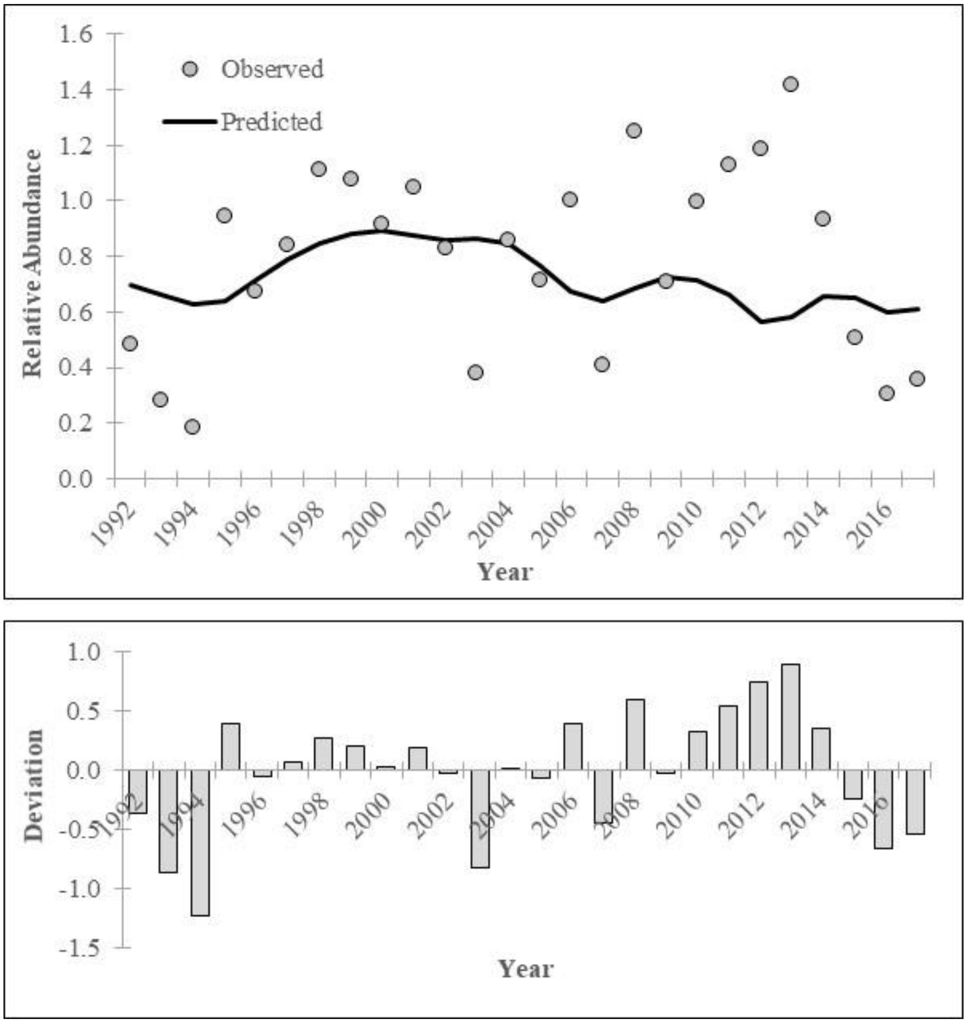

Figure 3.11. Observed and predicted relative abundance (top graph) and standardized residuals (bottom graph) for the P135spr survey from the base run of the stock assessment model, 1992–2017.

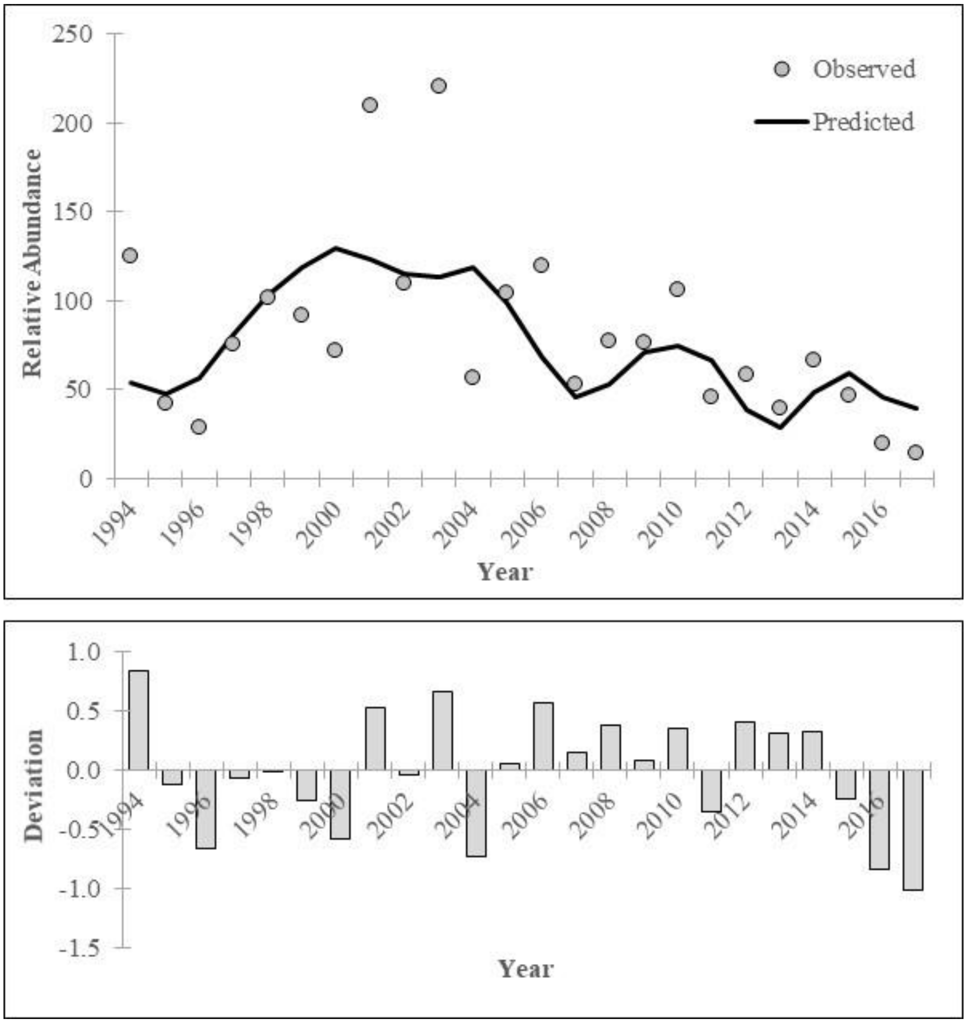

Figure 3.12. Observed and predicted relative abundance (top graph) and standardized residuals (bottom graph) for the RRef survey from the base run of the stock assessment model, 1994–2017.

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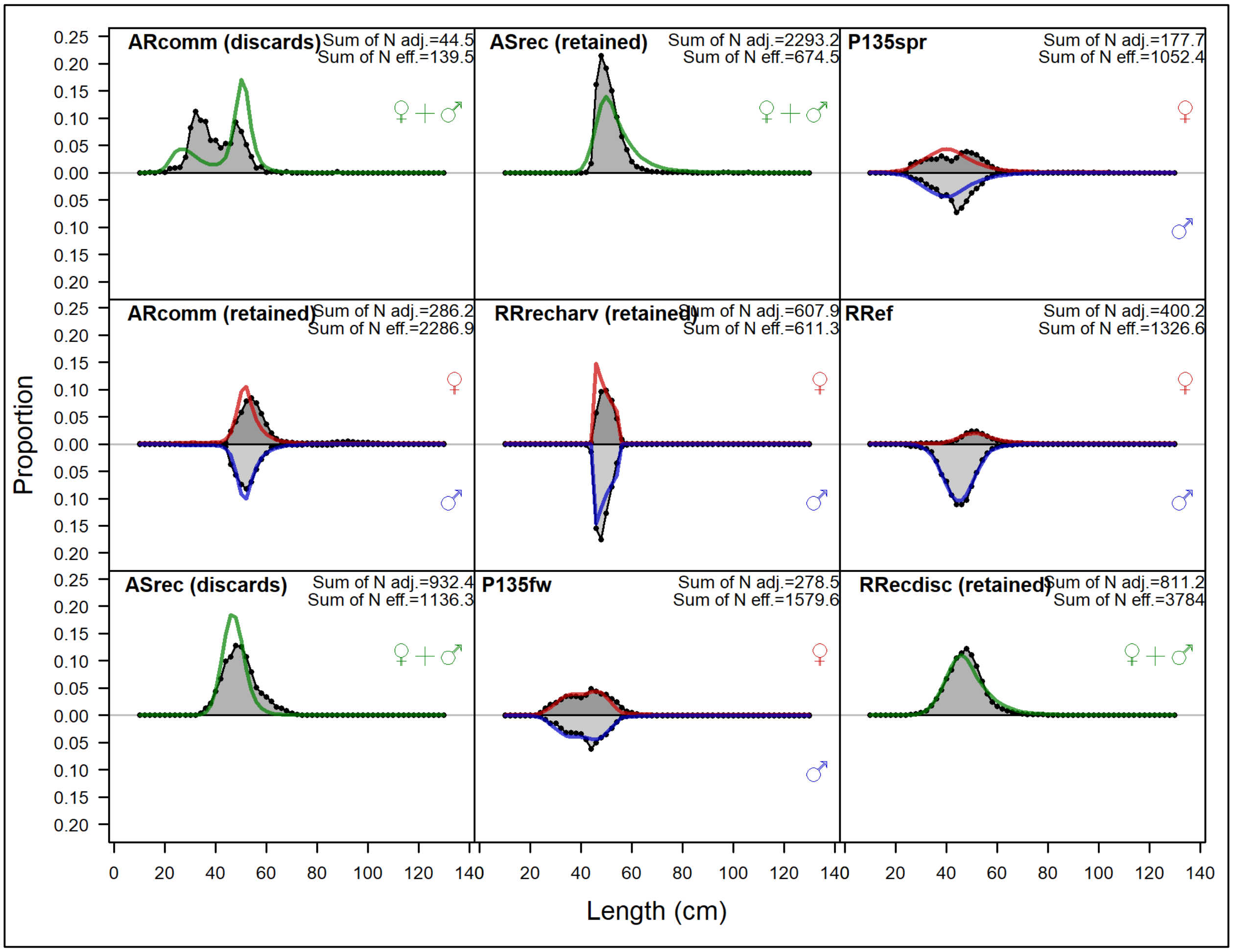

Figure 3.13. Observed and predicted length compositions for each data source from the base run of the stock assessment model aggregated across time. N adj. represents the input effective sample size (number of trips sampled) and N eff. represents the model estimate of effective sample size.

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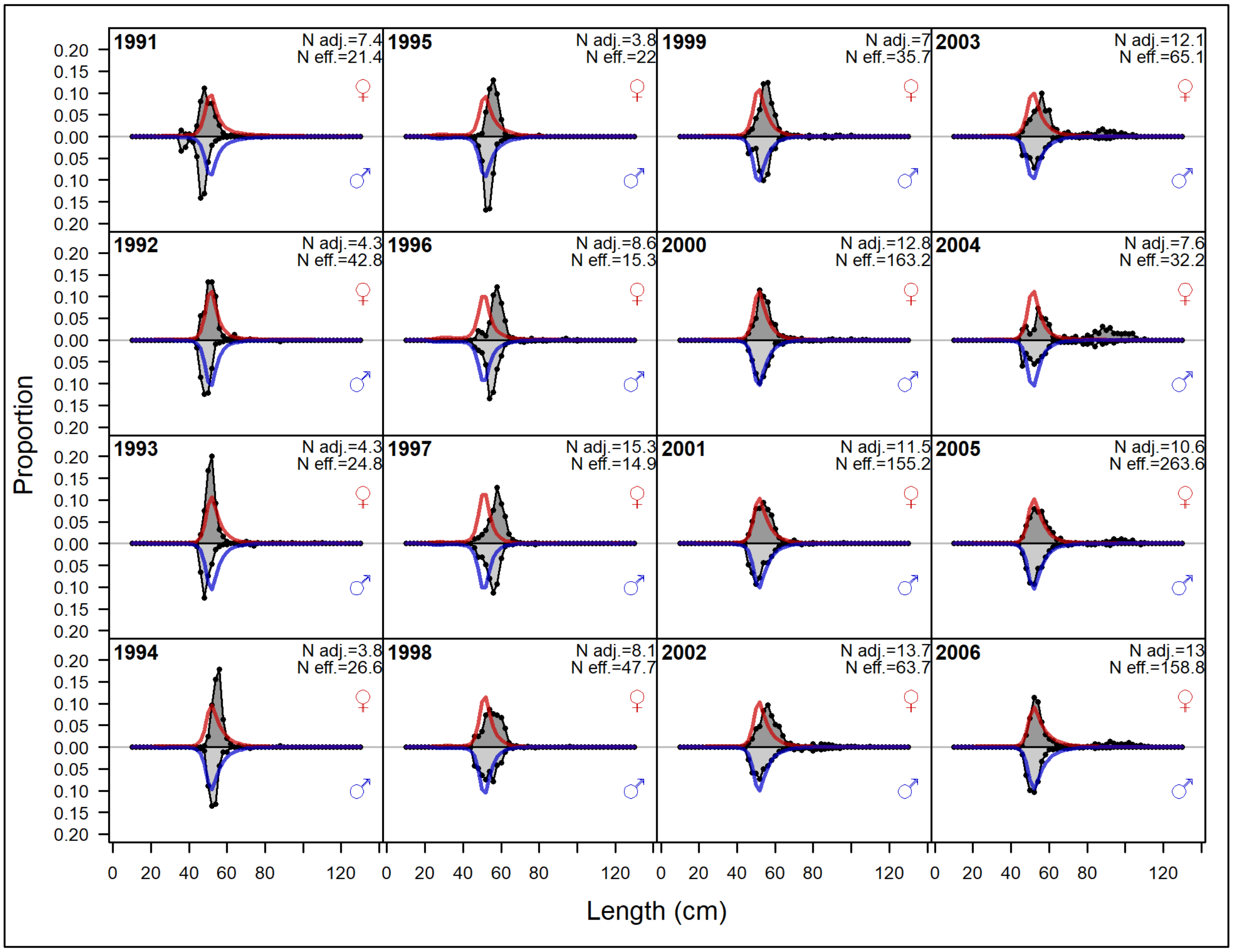

Figure 3.14. Observed and predicted length compositions for the ARcomm landings from the base run of the stock assessment model, 1991–2006. N adj. represents the input effective sample size (number of trips sampled) and N eff. represents the model estimate of effective sample size.

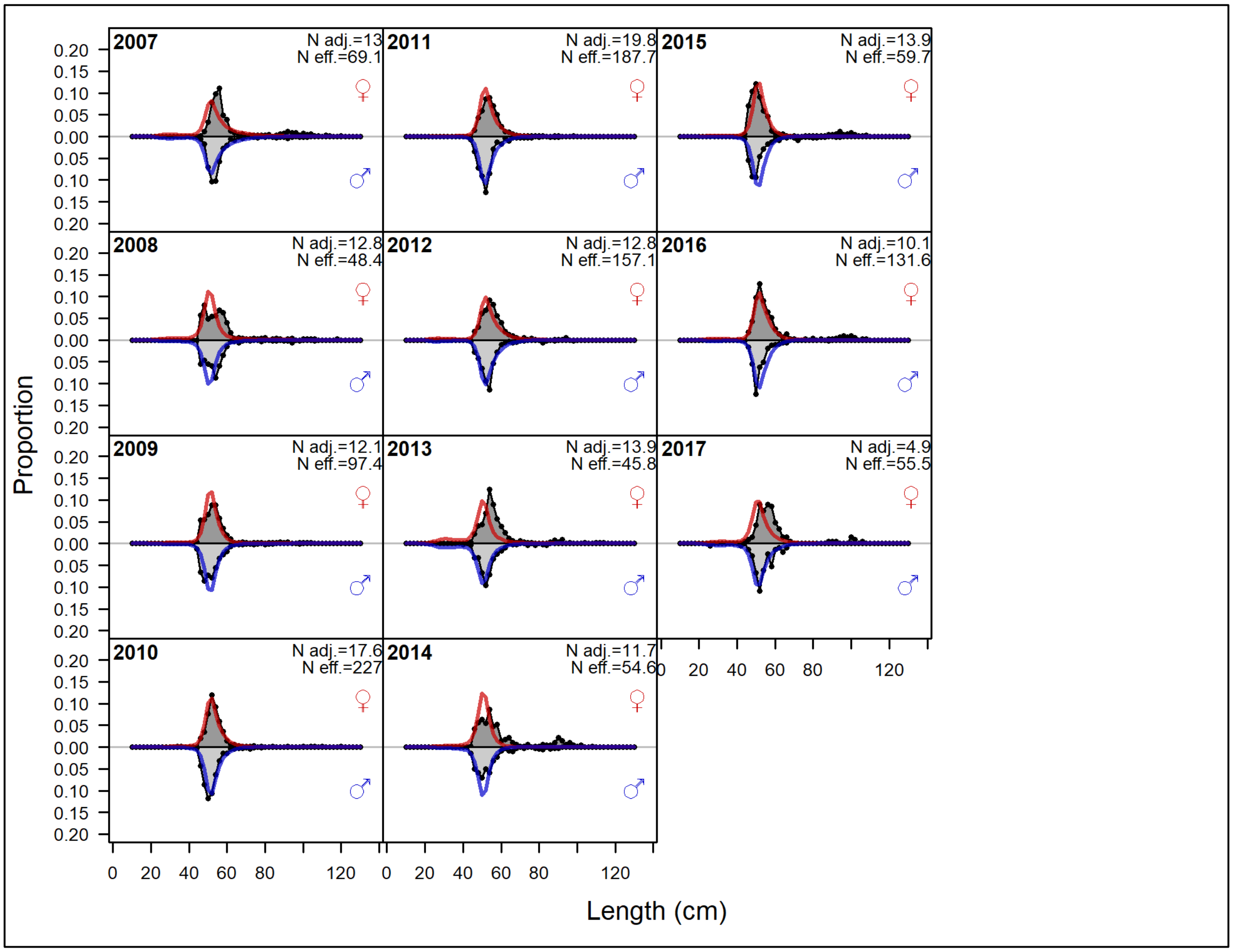

Figure 3.15. Observed and predicted length compositions for the ARcomm landings from the base run of the stock assessment model, 2007–2017. N adj. represents the input effective sample size (number of trips sampled) and N eff. represents the model estimate of effective sample size.

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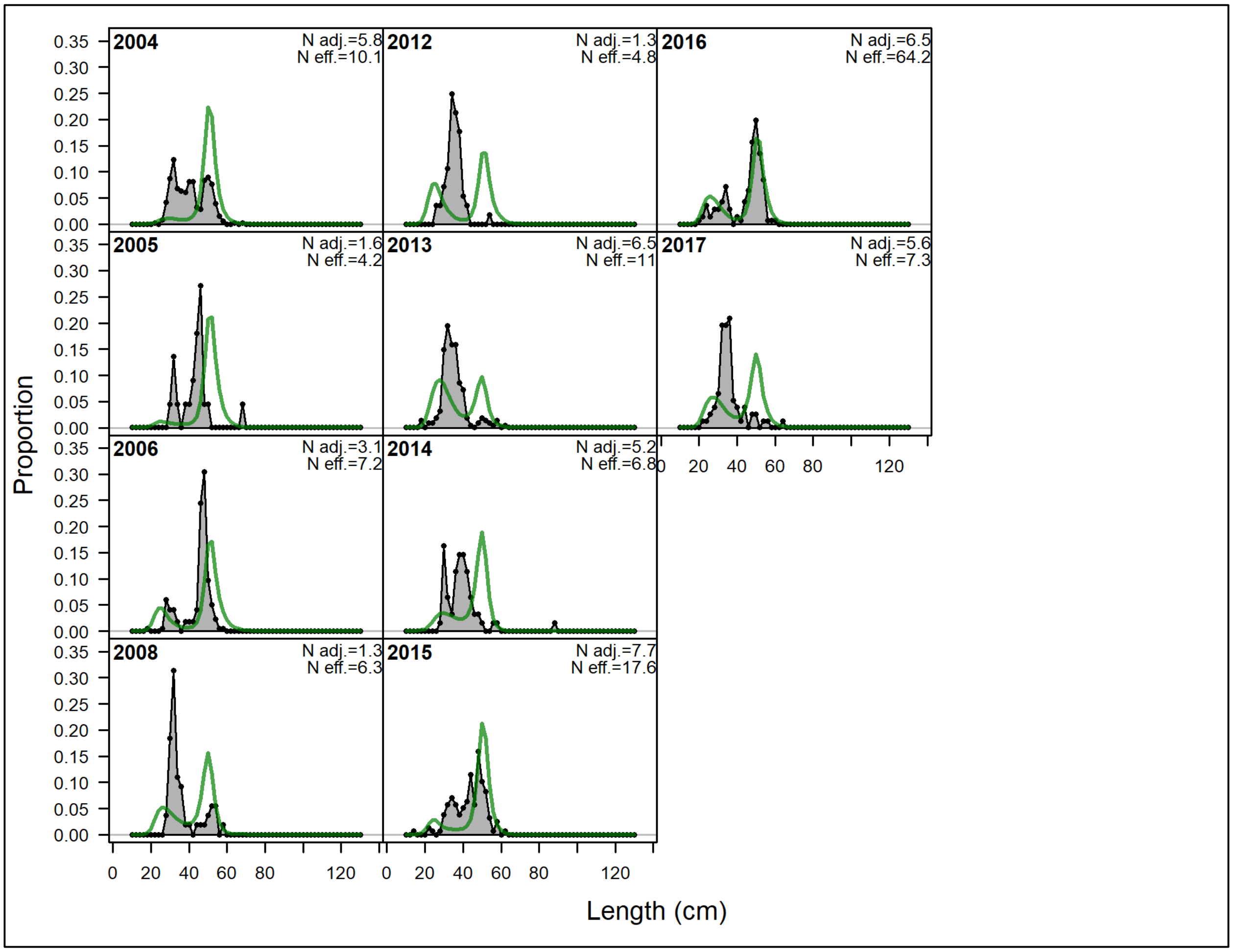

Figure 3.16. Observed and predicted length compositions for the ARcomm discards from the base run of the stock assessment model, 2004–2017. N adj. represents the input effective sample size (number of trips sampled) and N eff. represents the model estimate of effective sample size.

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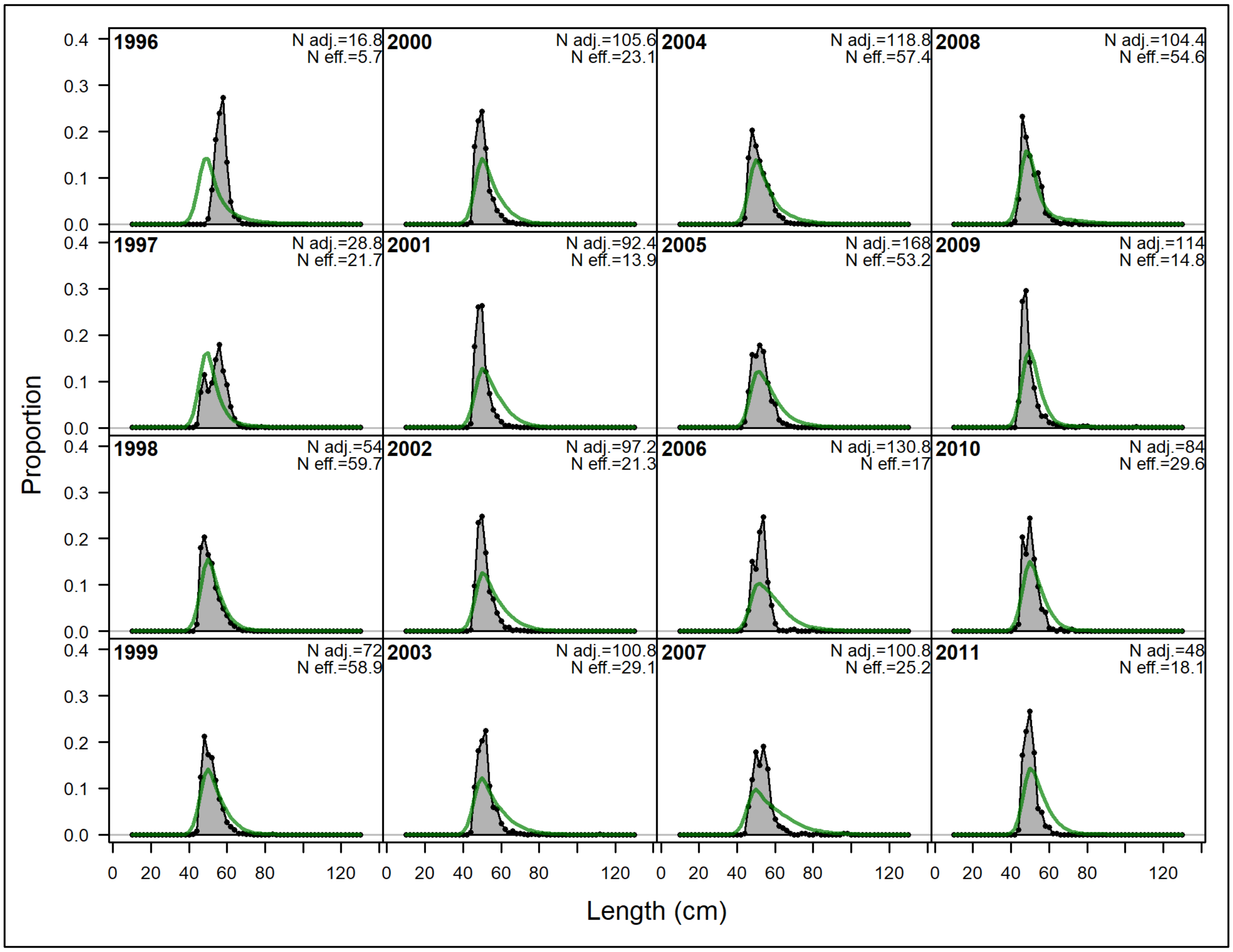

Figure 3.17. Observed and predicted length compositions for the ASrec harvest from the base run of the stock assessment model, 1996–2011. N adj. represents the input effective sample size (number of trips sampled) and N eff. represents the model estimate of effective sample size.

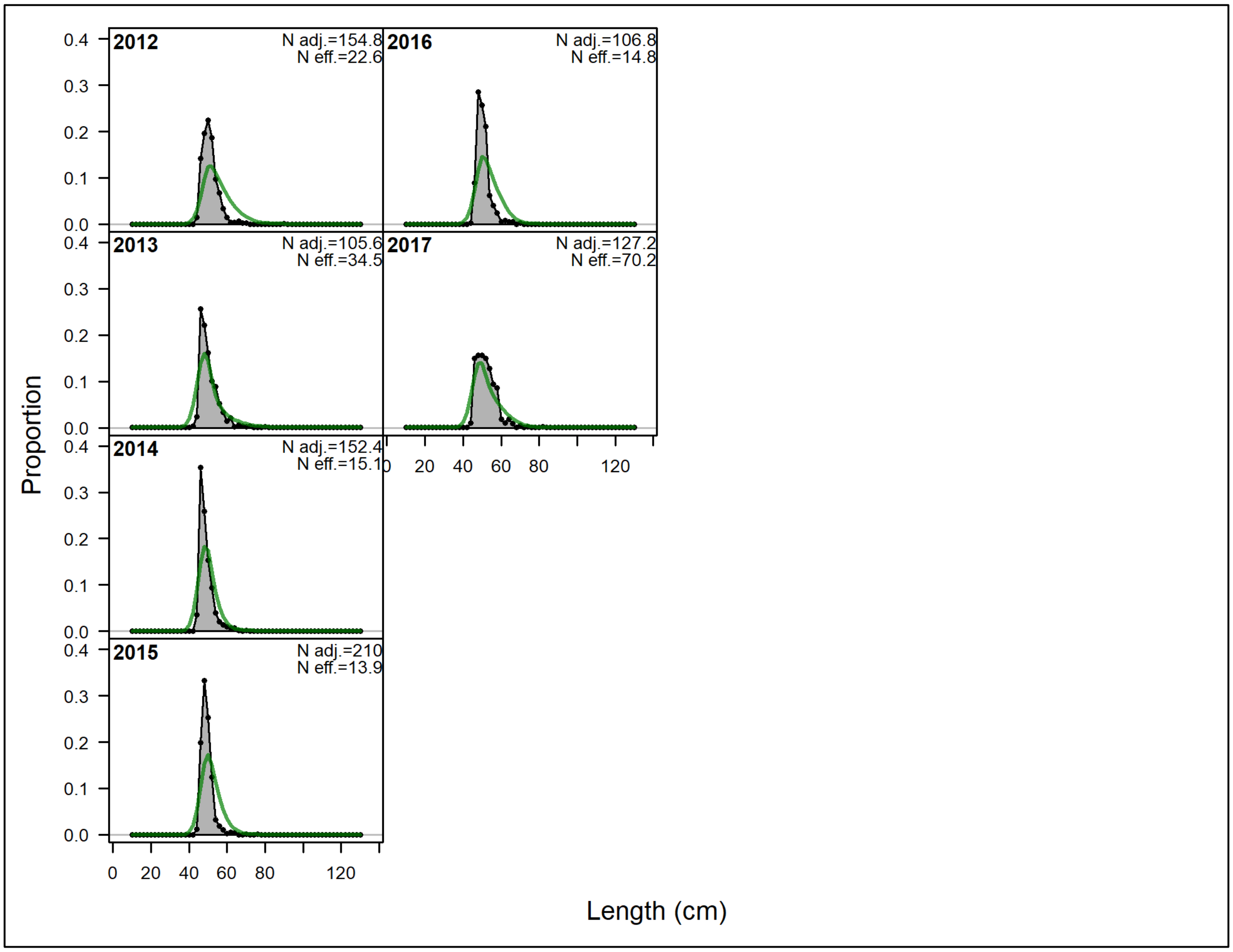

Figure 3.18. Observed and predicted length compositions for the ASrec harvest from the base run of the stock assessment model, 2012–2017. N adj. represents the input effective sample size (number of trips sampled) and N eff. represents the model estimate of effective sample size.

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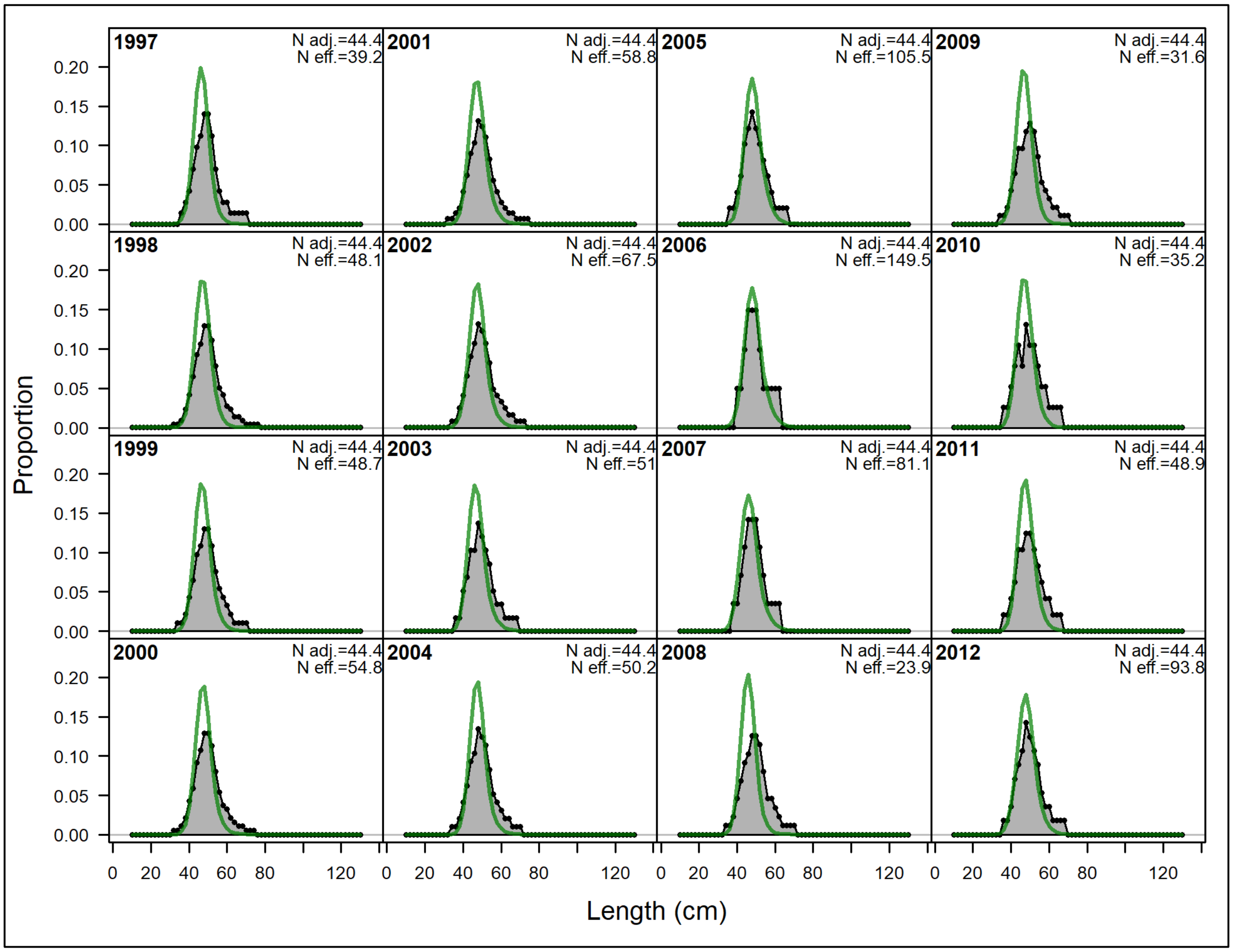

Figure 3.19. Observed and predicted length compositions for the ASrec discards from the base run of the stock assessment model, 1997–2012. N adj. represents the input effective sample size (number of trips sampled) and N eff. represents the model estimate of effective sample size.

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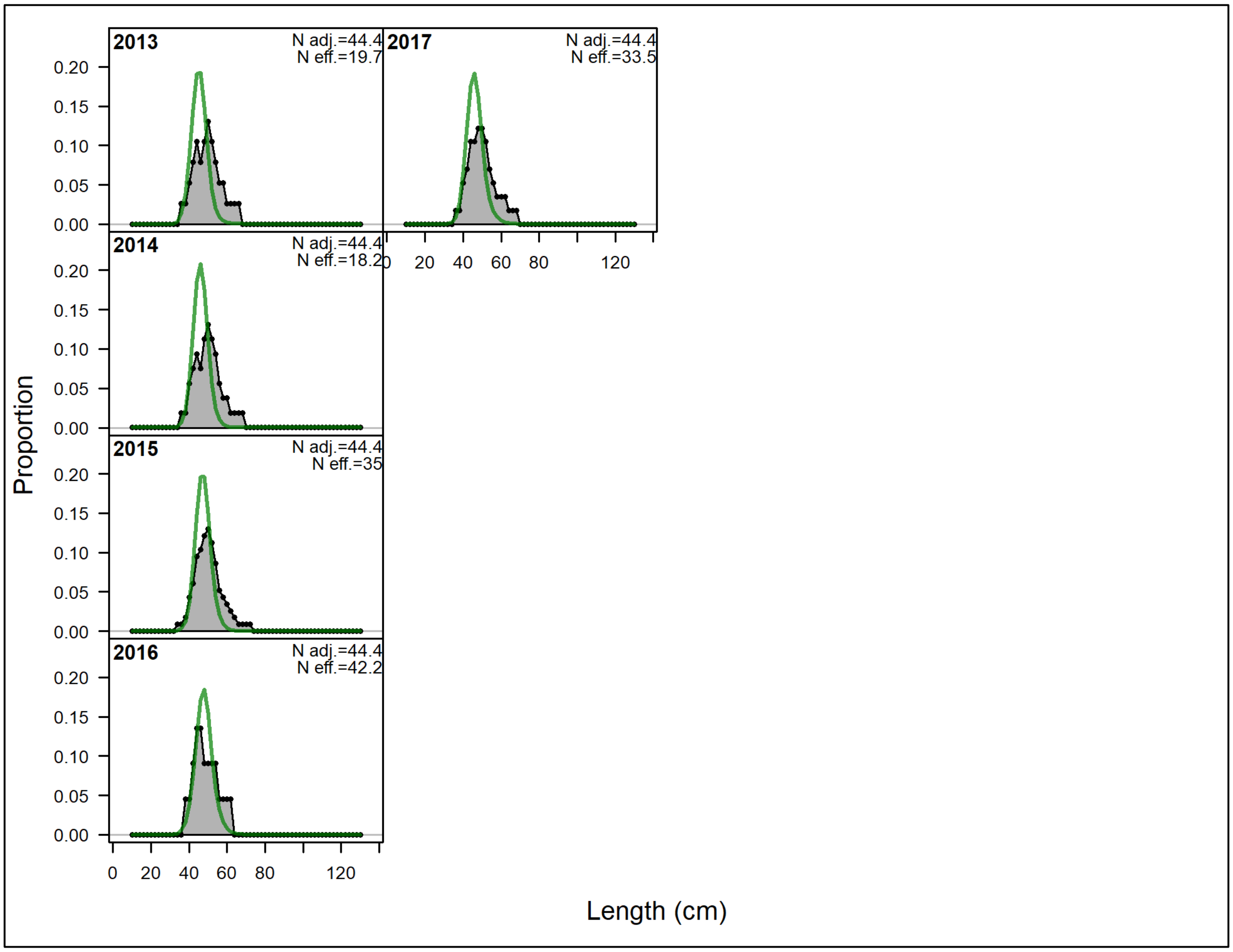

Figure 3.20. Observed and predicted length compositions for the ASrec discards from the base run of the stock assessment model, 2013–2017. N adj. represents the input effective sample size (number of trips sampled) and N eff. represents the model estimate of effective sample size.

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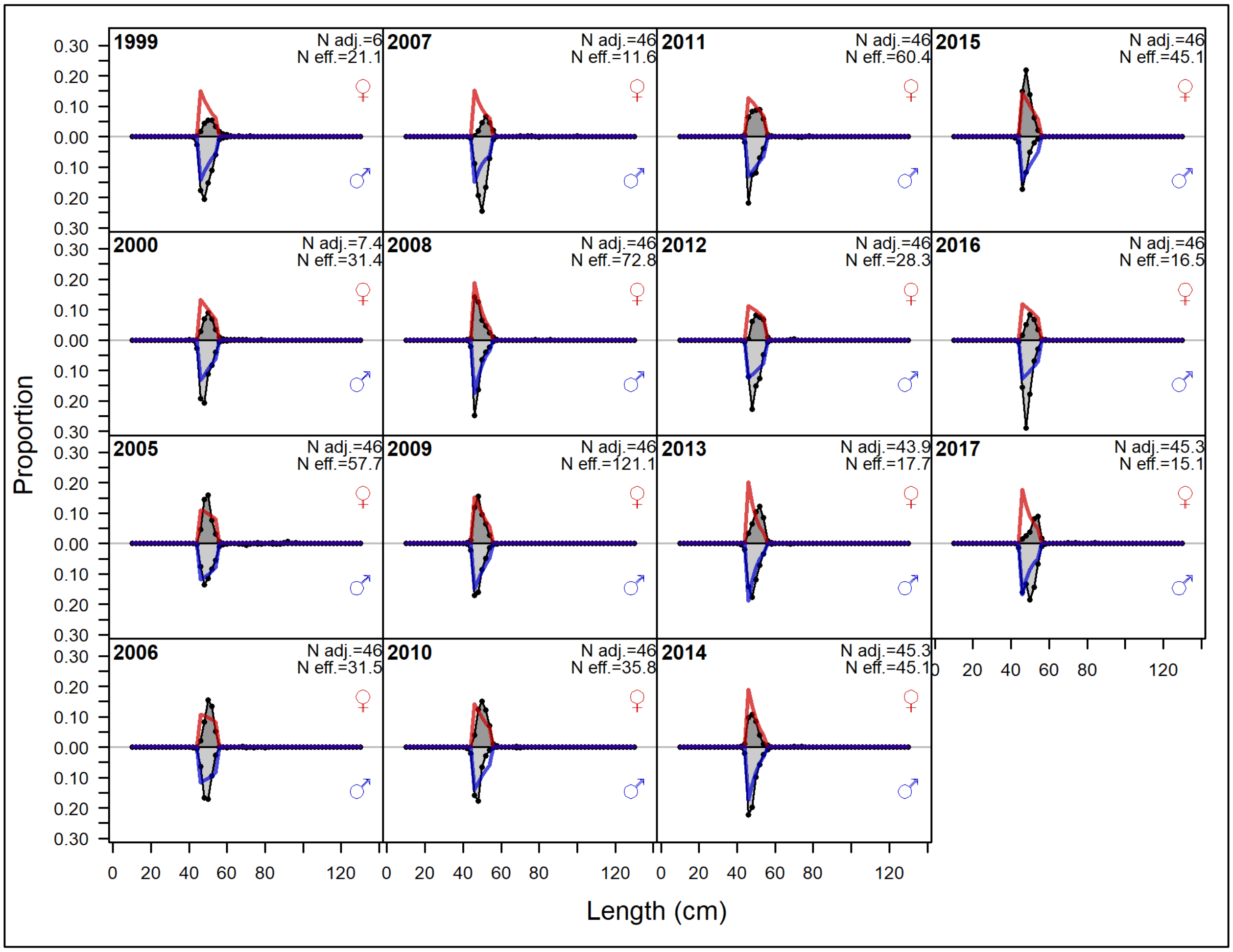

Figure 3.21. Observed and predicted length compositions for the RRrec harvest from the base run of the stock assessment model, 1999–2017. N adj. represents the input effective sample size (number of trips sampled) and N eff. represents the model estimate of effective sample size.

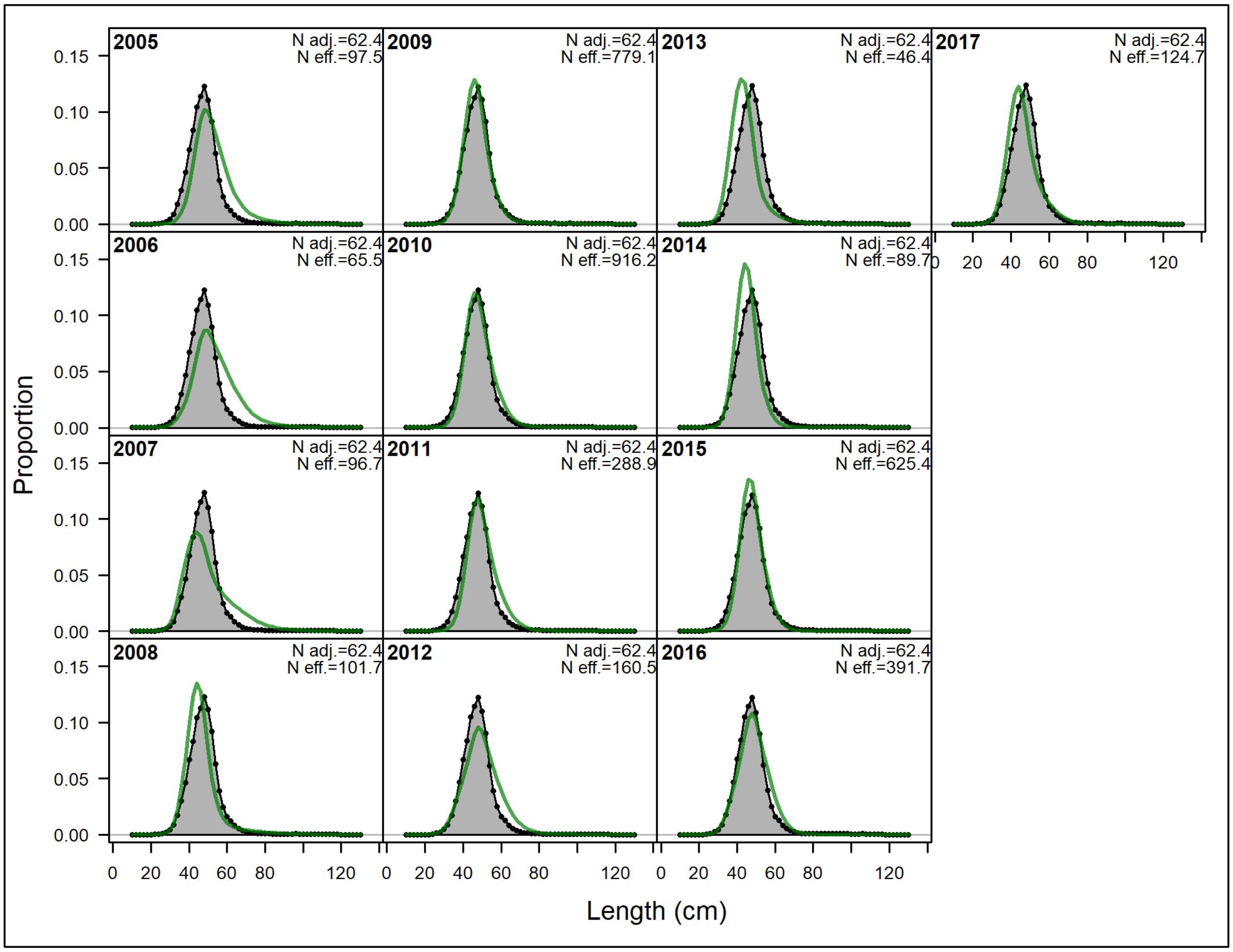

Figure 3.22. Observed and predicted length compositions for the RRrec discards from the base run of the stock assessment model, 2005–2017. N adj. represents the input effective sample size (number of trips sampled) and N eff. represents the model estimate of effective sample size.

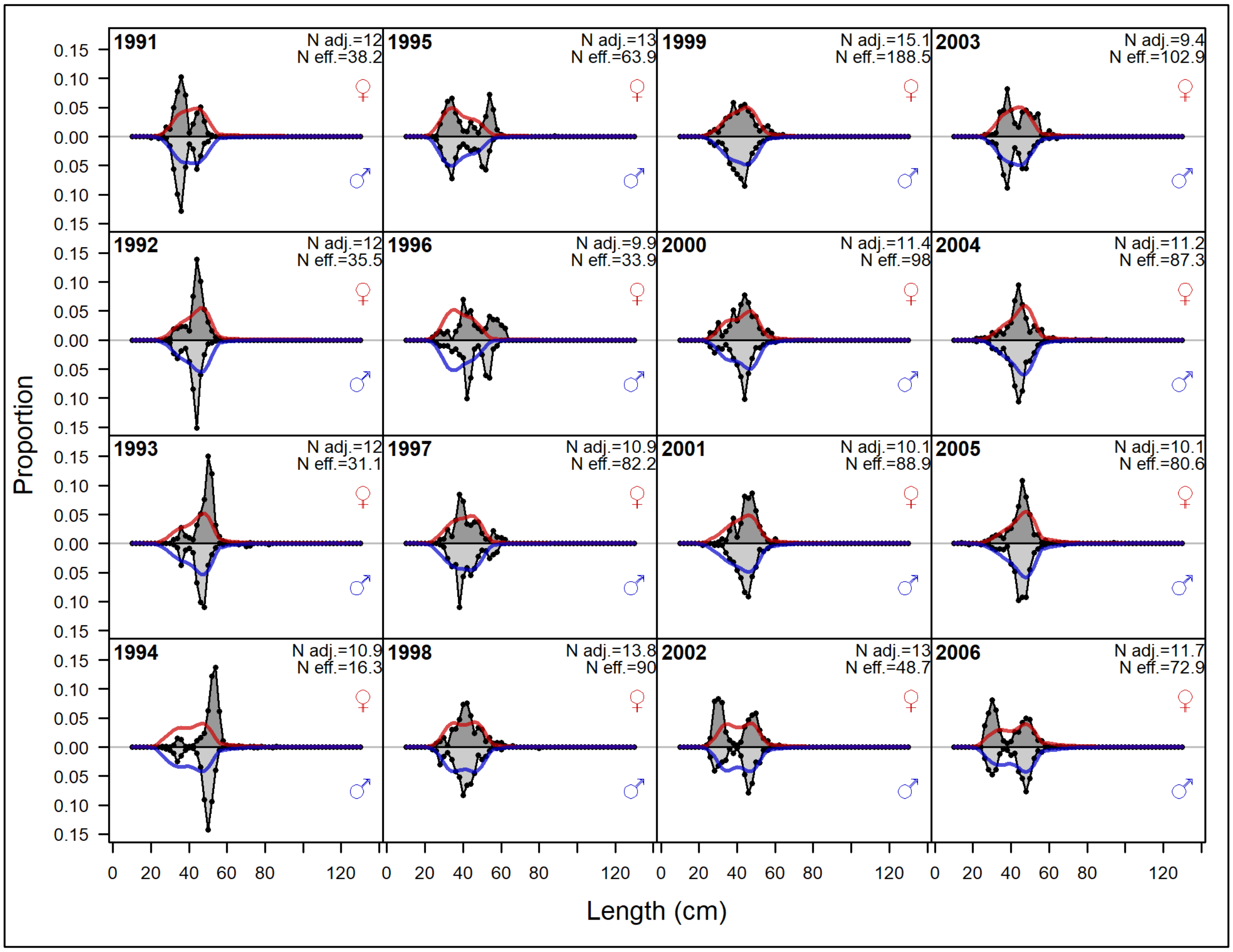

Figure 3.23. Observed and predicted length compositions for the P135fw survey from the base run of the stock assessment model, 1991–2006. N adj. represents the input effective sample size (number of trips sampled) and N eff. represents the model estimate of effective sample size.

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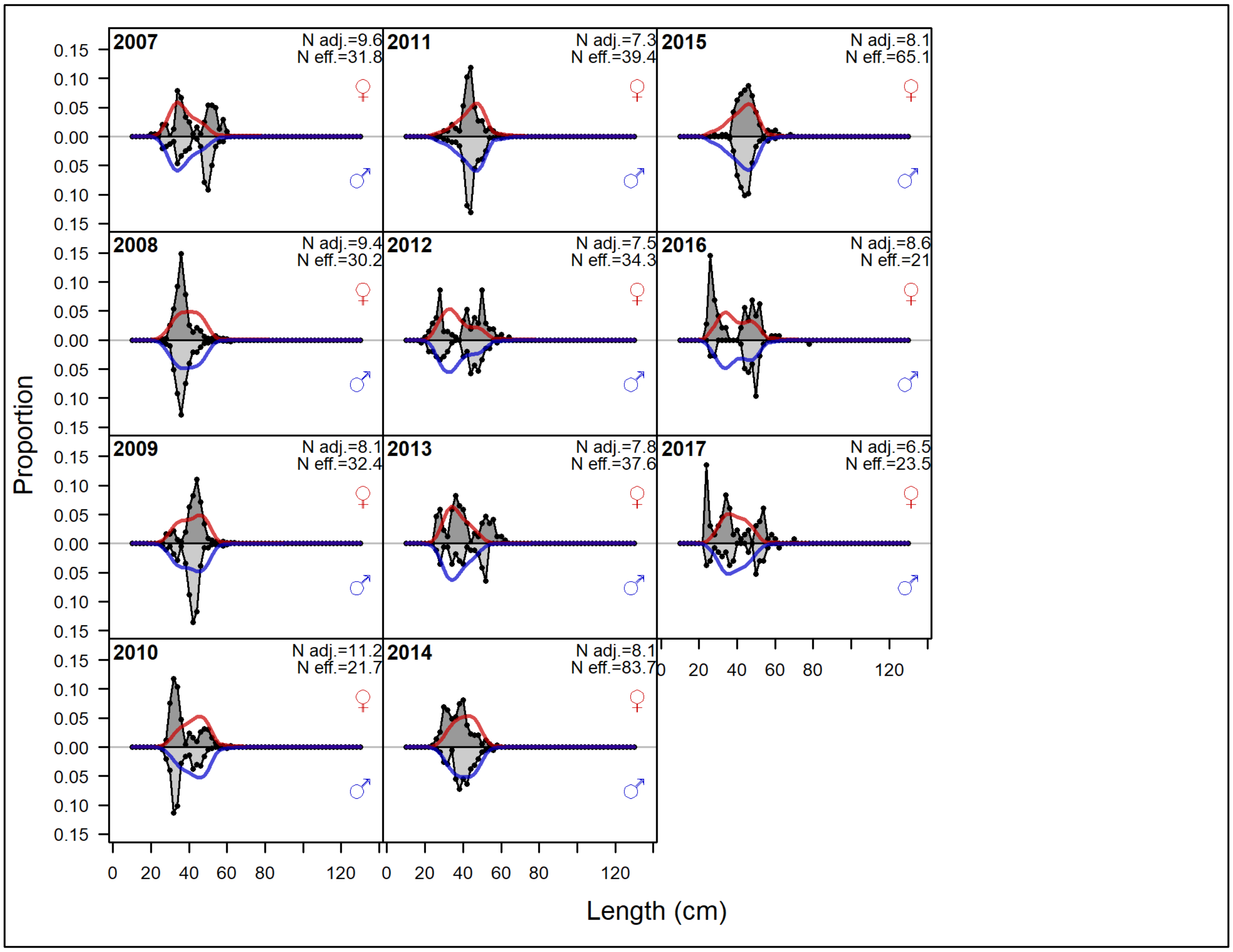

Figure 3.24. Observed and predicted length compositions for the P135fw survey from the base run of the stock assessment model, 2007–2017. N adj. represents the input effective sample size (number of trips sampled) and N eff. represents the model estimate of effective sample size.

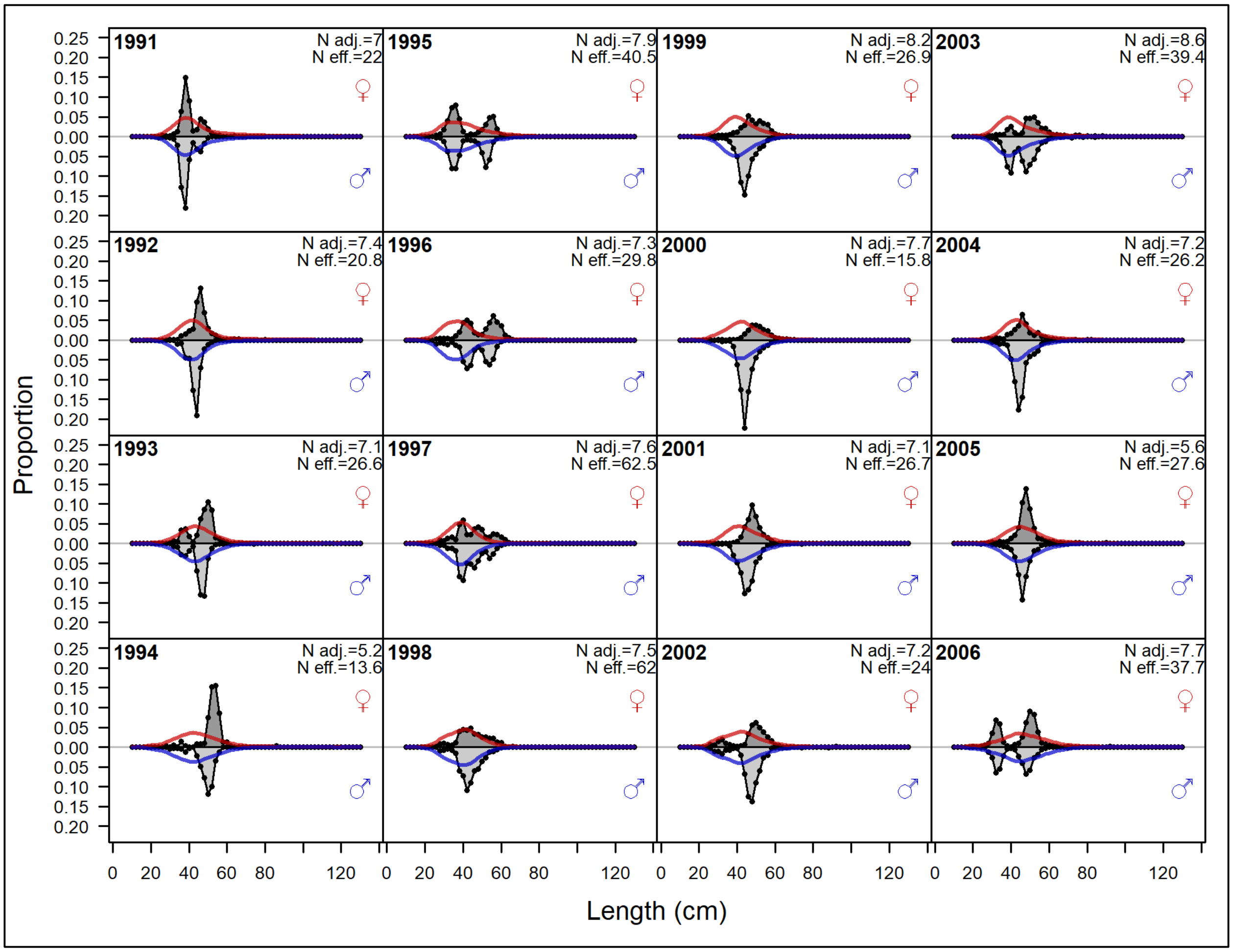

Figure 3.25. Observed and predicted length compositions for the P135spr survey from the base run of the stock assessment model, 1991–2006. N adj. represents the input effective sample size (number of trips sampled) and N eff. represents the model estimate of effective sample size.

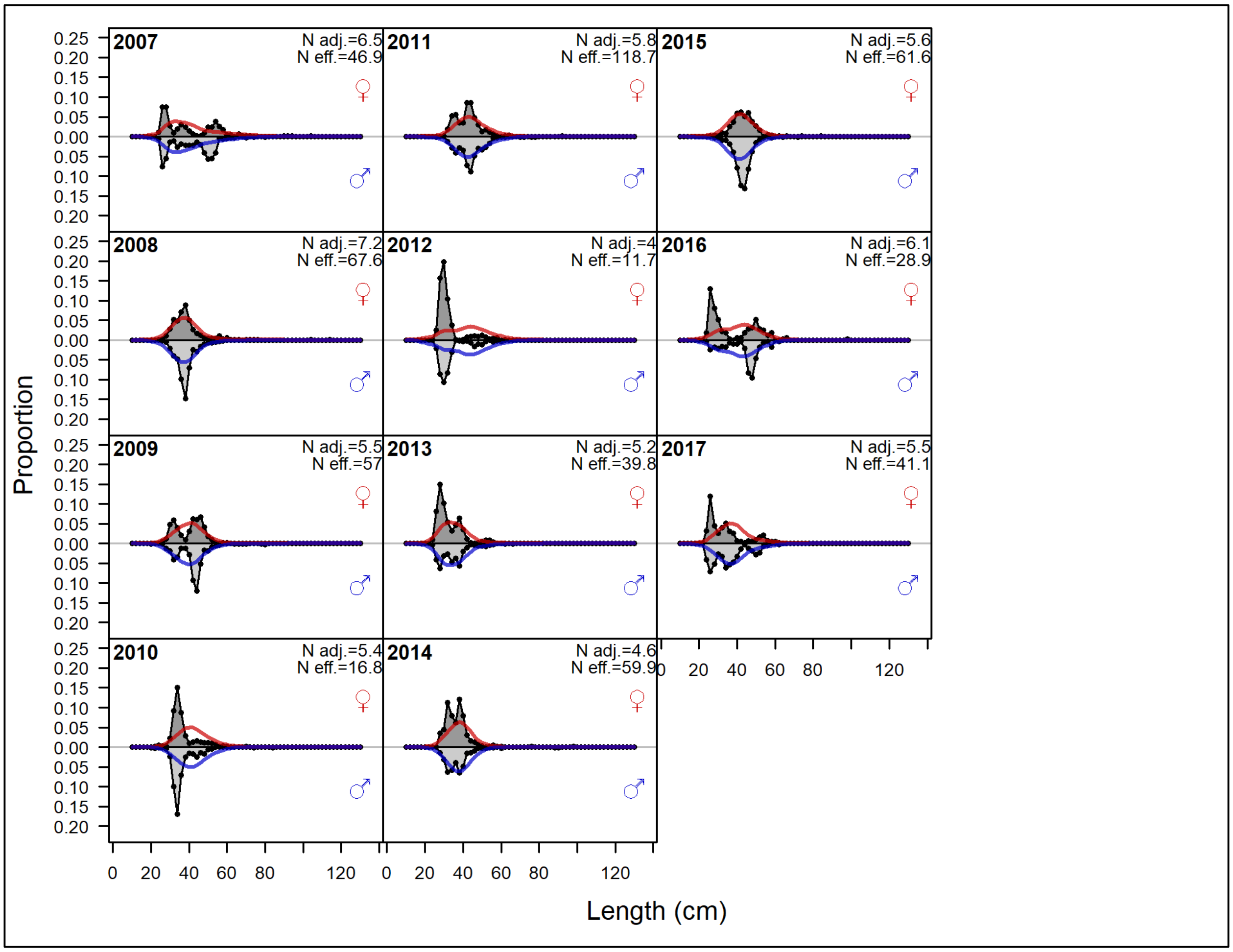

Figure 3.26. Observed and predicted length compositions for the P135spr survey from the base run of the stock assessment model, 2007–2017. N adj. represents the input effective sample size (number of trips sampled) and N eff. represents the model estimate of effective sample size.

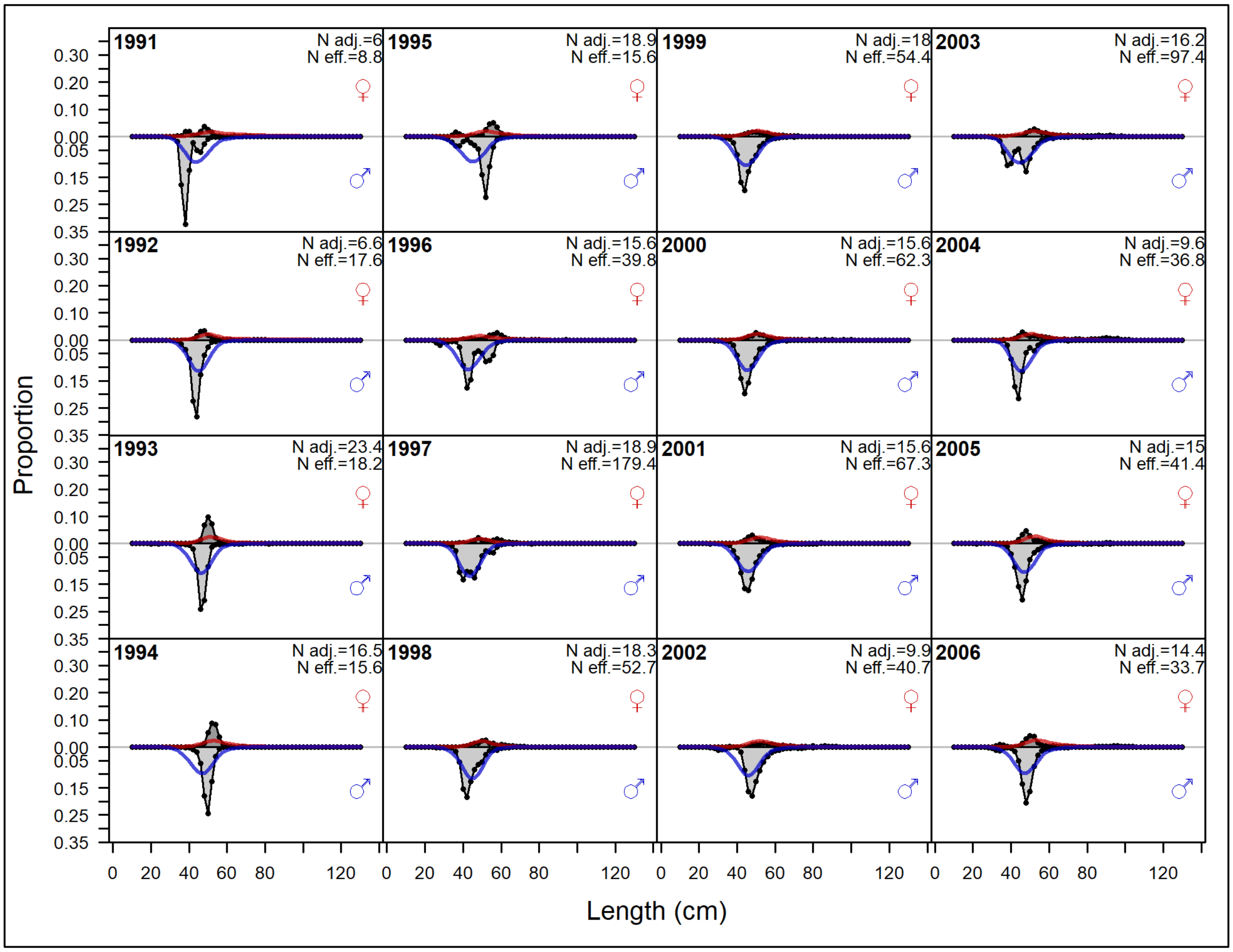

Figure 3.27. Observed and predicted length compositions for the RRef survey from the base run of the stock assessment model, 1991–2006. N adj. represents the input effective sample size (number of trips sampled) and N eff. represents the model estimate of effective sample size.

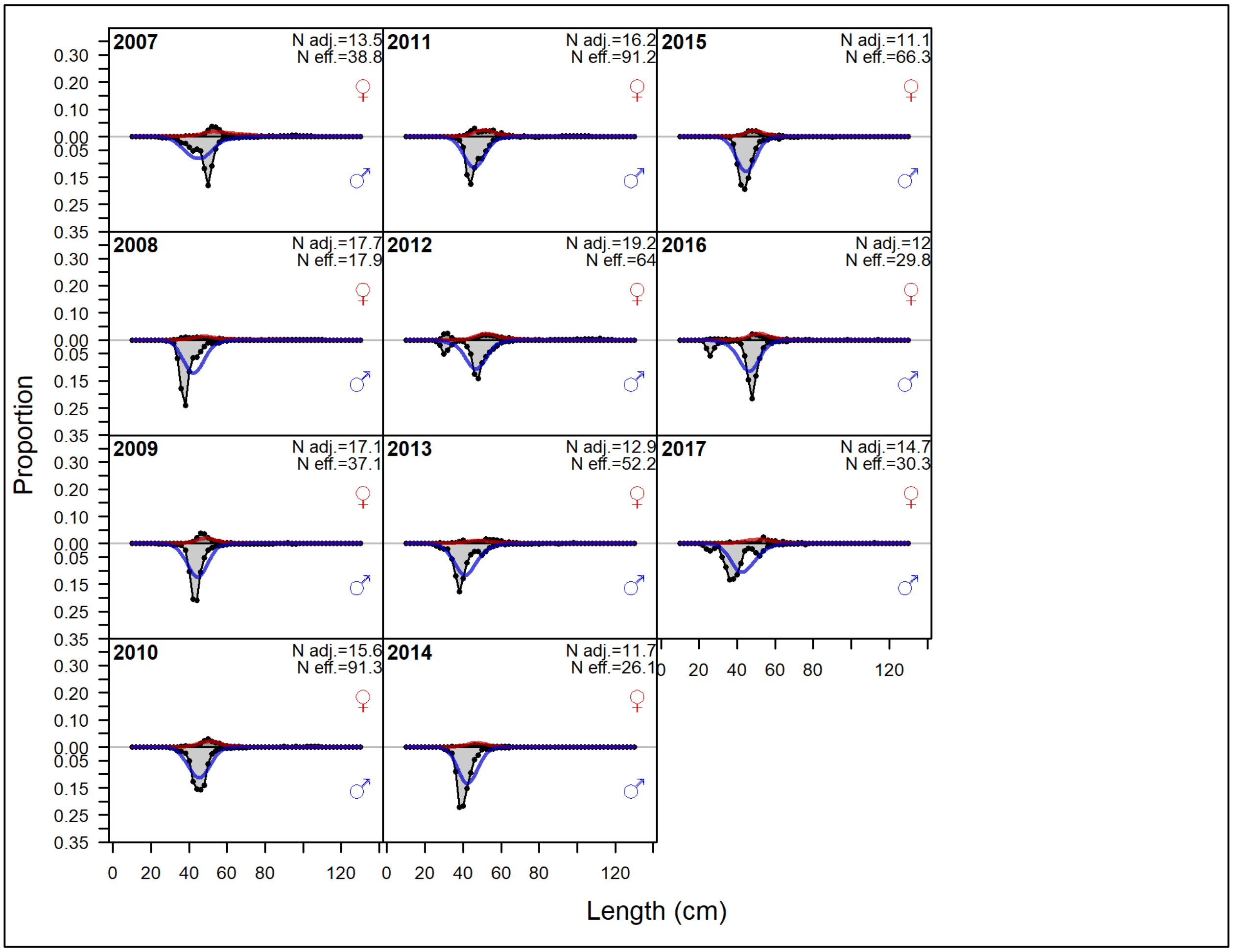

Figure 3.28. Observed and predicted length compositions for the RRef survey from the base run of the stock assessment model, 2007–2017. N adj. represents the input effective sample size (number of trips sampled) and N eff. represents the model estimate of effective sample size.

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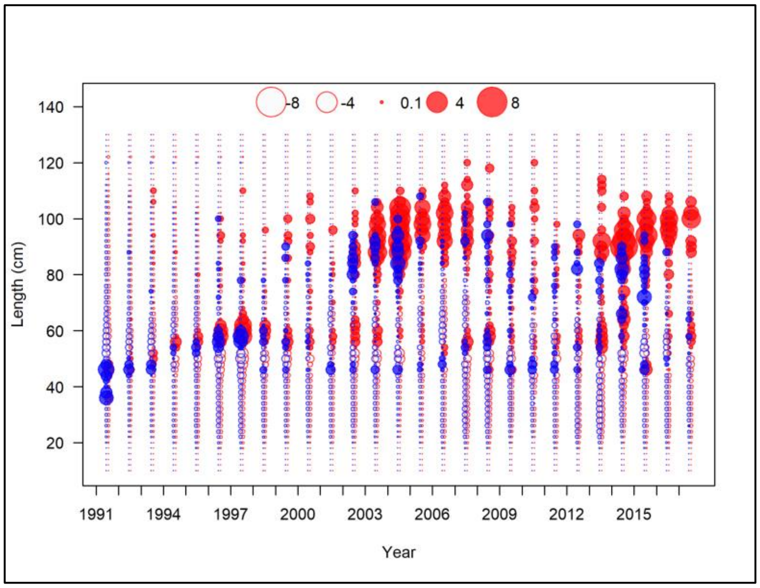

Figure 3.29. Pearson residuals (red: female; blue: male) from the fit of the base model run to the ARcomm landings length composition data, 1991–2017. Closed bubbles represent positive residuals (observed > expected) and open bubbles represent negative residuals (observed < expected).

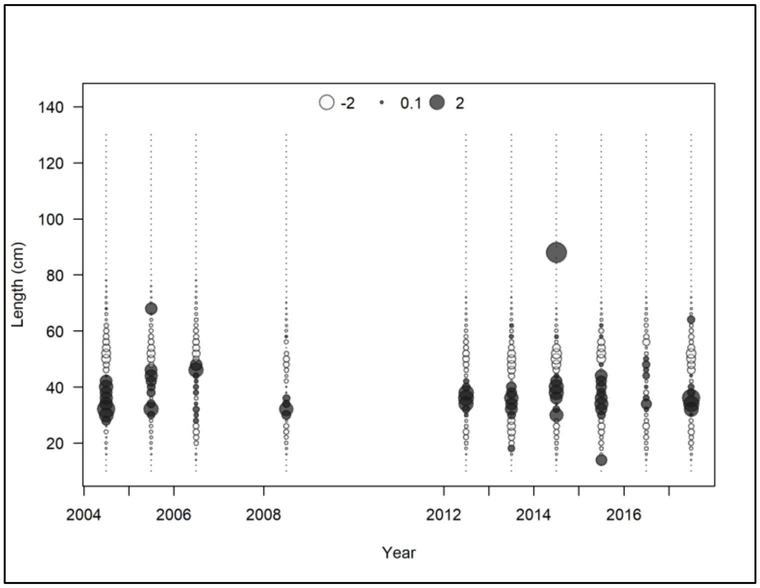

Figure 3.30. Pearson residuals from the fit of the base model run to the ARcomm discards length composition data, 1991–2017. Closed bubbles represent positive residuals (observed > expected) and open bubbles represent negative residuals (observed < expected).

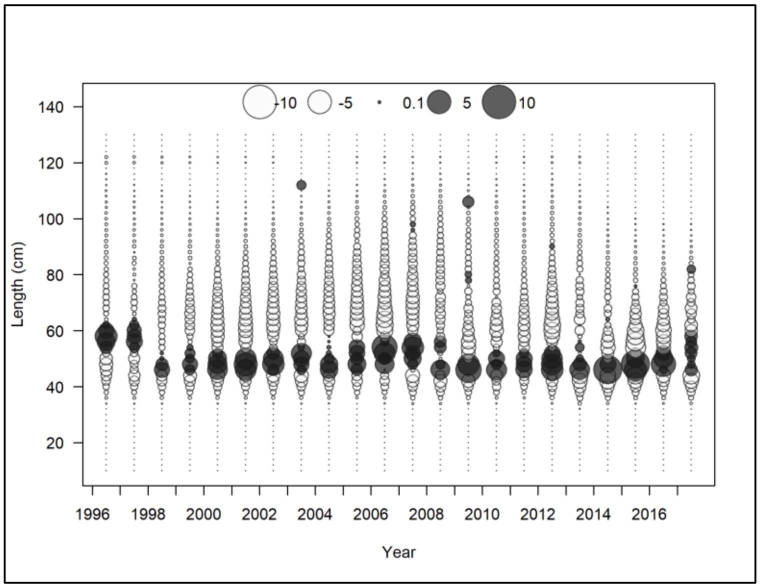

Figure 3.31. Pearson residuals from the fit of the base model run to the ASrec harvest length composition data, 1996–2017. Closed bubbles represent positive residuals (observed > expected) and open bubbles represent negative residuals (observed < expected).

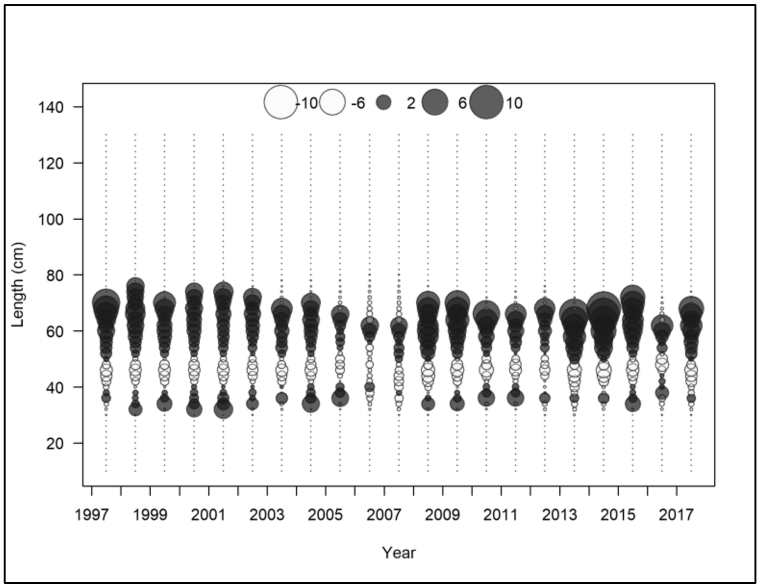

Figure 3.32. Pearson residuals from the fit of the base model run to the ASrec discard length composition data, 1997–2017. Closed bubbles represent positive residuals (observed > expected) and open bubbles represent negative residuals (observed < expected).

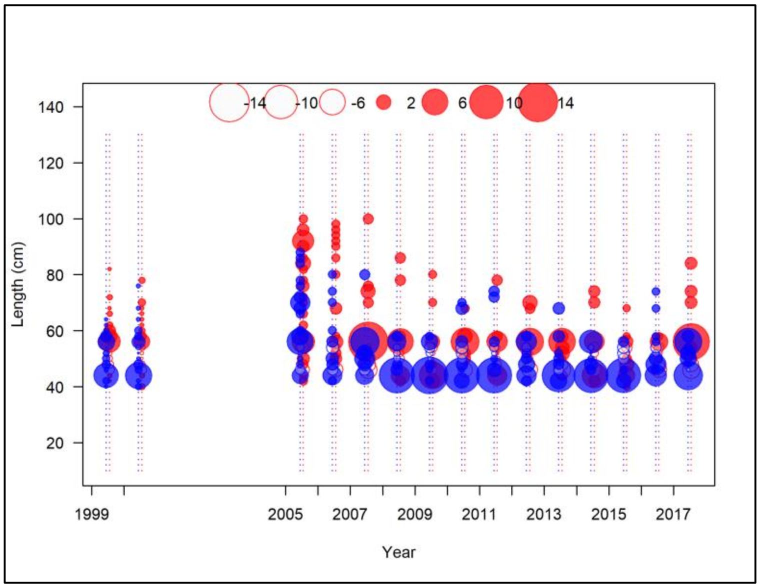

Figure 3.33. Pearson residuals (red: female; blue: male) from the fit of the base model run to the RRrec harvest length composition data, 1999–2017. Closed bubbles represent positive residuals (observed > expected) and open bubbles represent negative residuals (observed < expected).

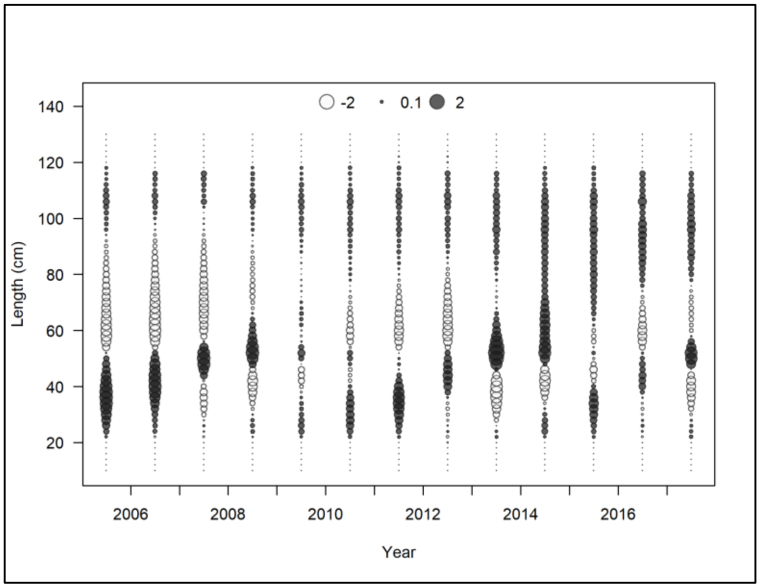

Figure 3.34. Pearson residuals from the fit of the base model run to the RRrec discard length composition data, 2005–2017. Closed bubbles represent positive residuals (observed > expected) and open bubbles represent negative residuals (observed < expected).

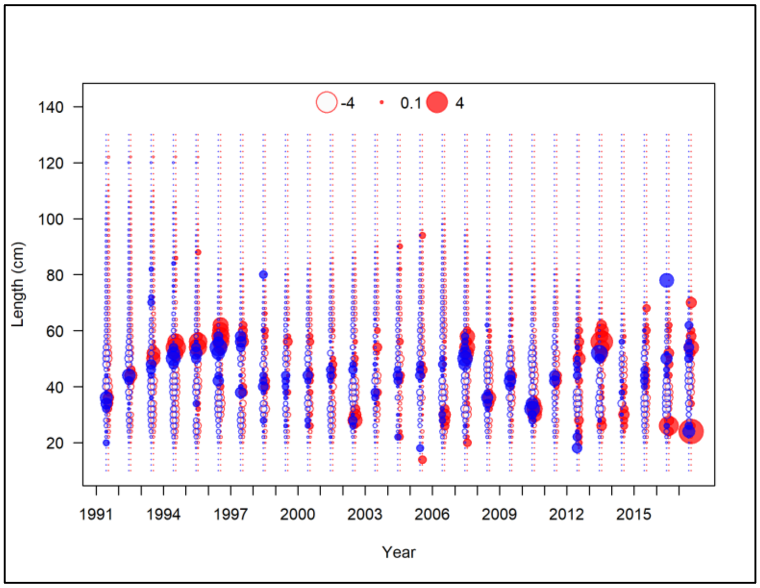

Figure 3.35. Pearson residuals (red: female; blue: male) from the fit of the base model run to the P135fw survey length composition data, 1991–2017. Closed bubbles represent positive residuals (observed > expected) and open bubbles represent negative residuals (observed < expected).

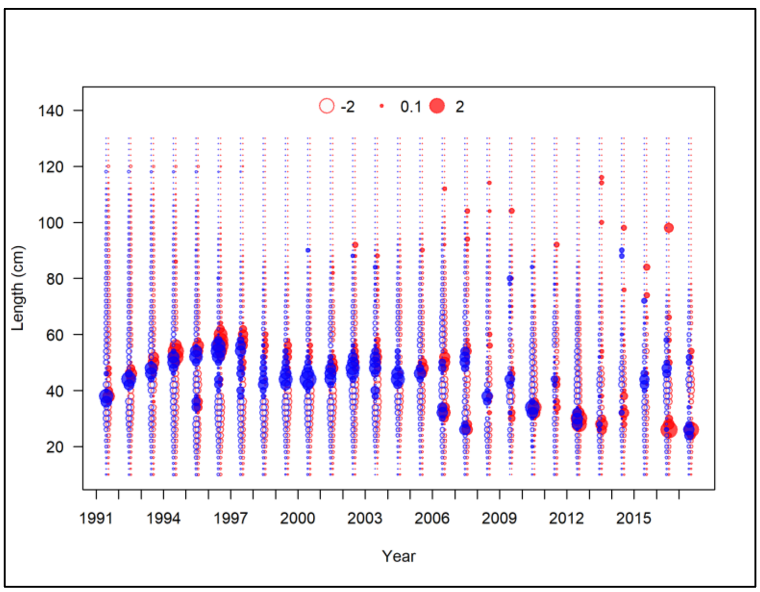

Figure 3.36. Pearson residuals (red: female; blue: male) from the fit of the base model run to the P135spr survey length composition data, 1991–2017. Closed bubbles represent positive residuals (observed > expected) and open bubbles represent negative residuals (observed < expected).

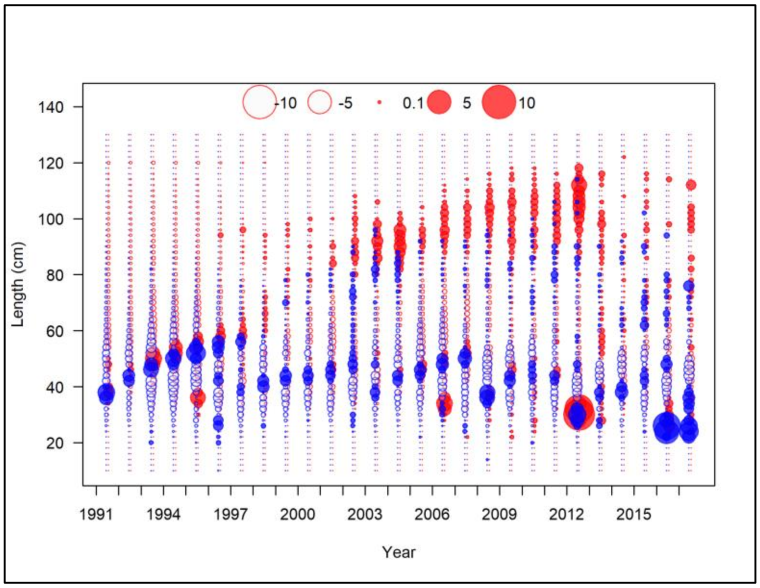

Figure 3.37. Pearson residuals (red: female; blue: male) from the fit of the base model run to the RRef survey length composition data, 1991–2017. Closed bubbles represent positive residuals (observed > expected) and open bubbles represent negative residuals (observed < expected).

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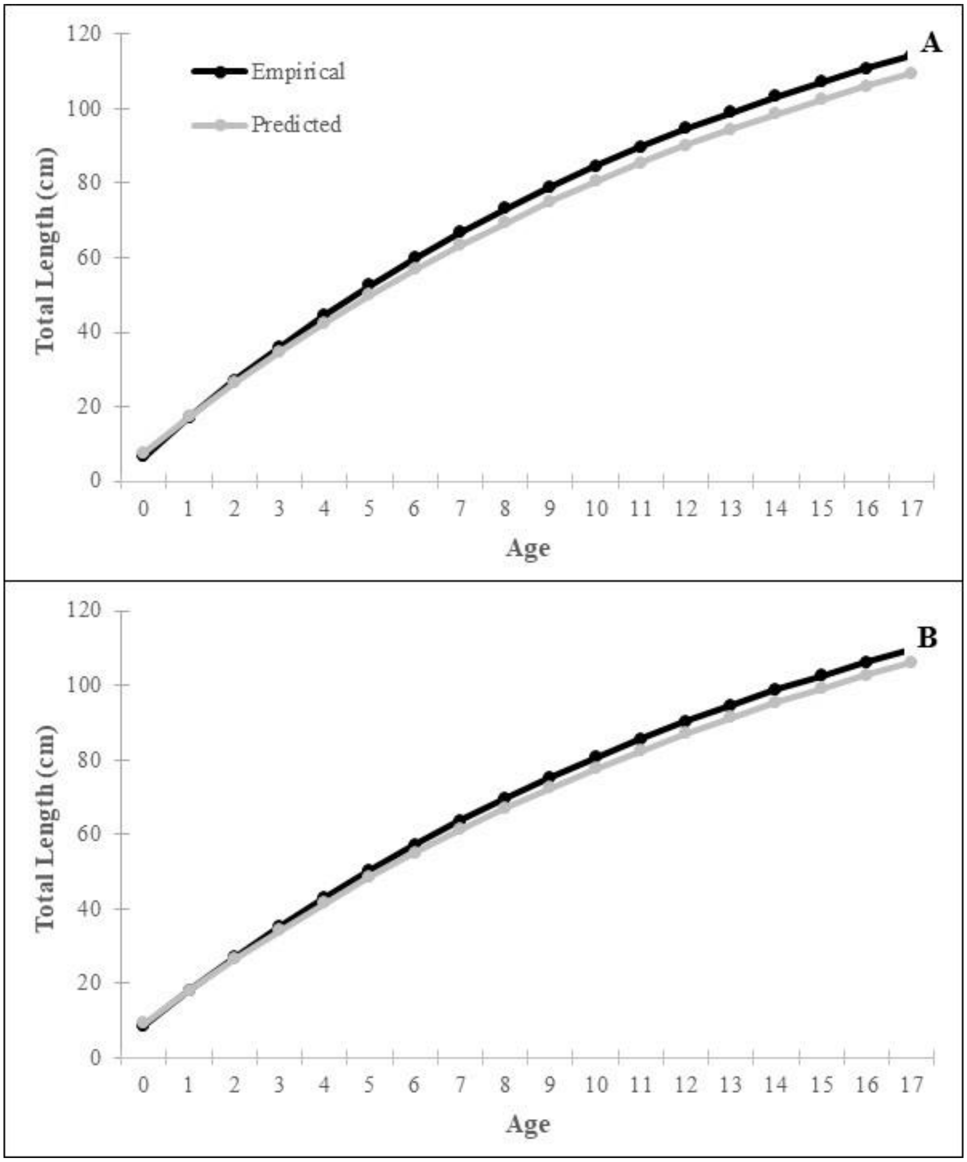

Figure 3.38. Comparison of empirical and model-predicted age-length growth curves for (A) female and (B) male striped bass from the base run of the stock assessment model.

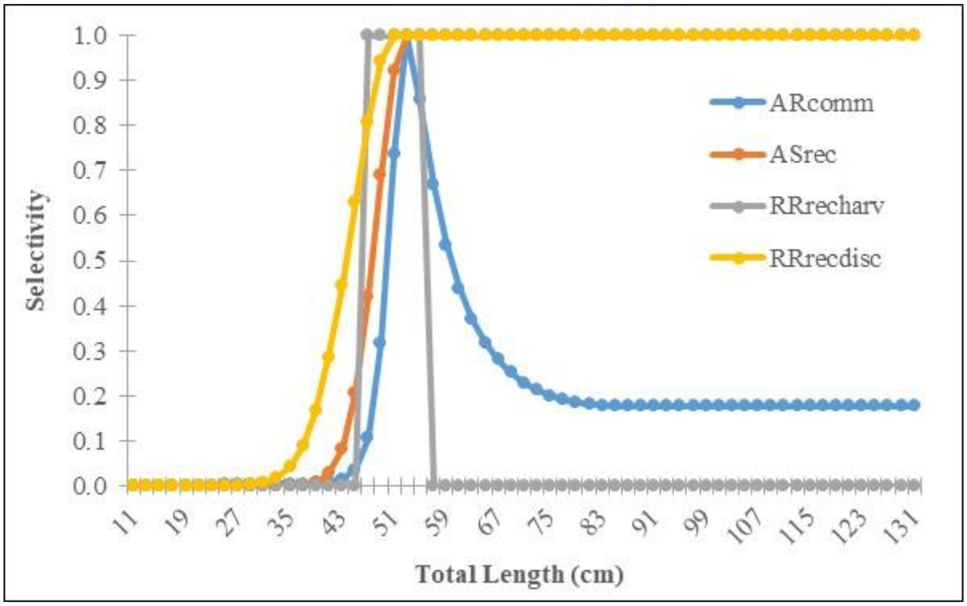

Figure 3.39. Predicted length-based selectivity for the fleets from the base run of the stock assessment model.

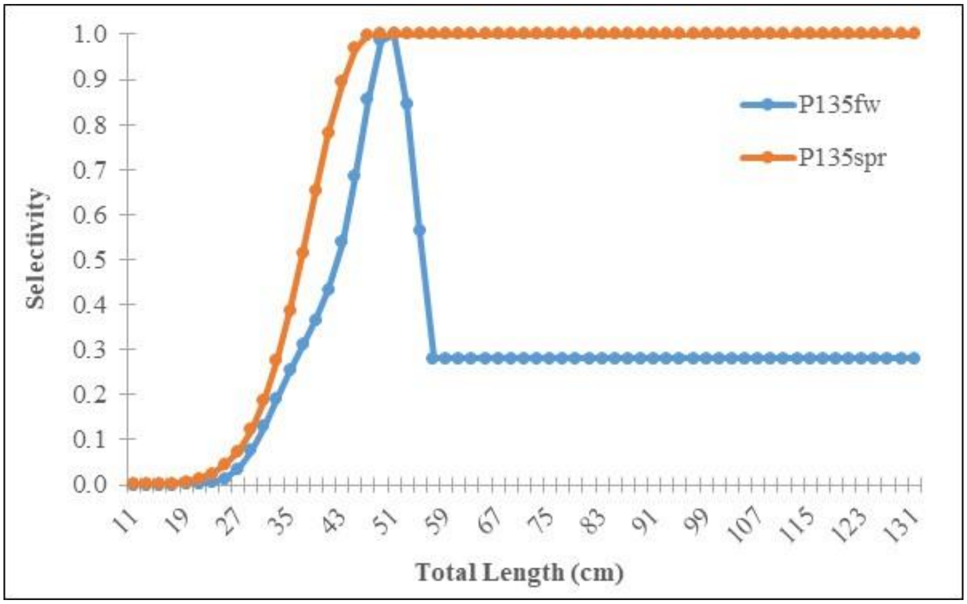

Figure 3.40. Predicted length-based selectivity for the P135fw and P135spr surveys from the base run of the stock assessment model.

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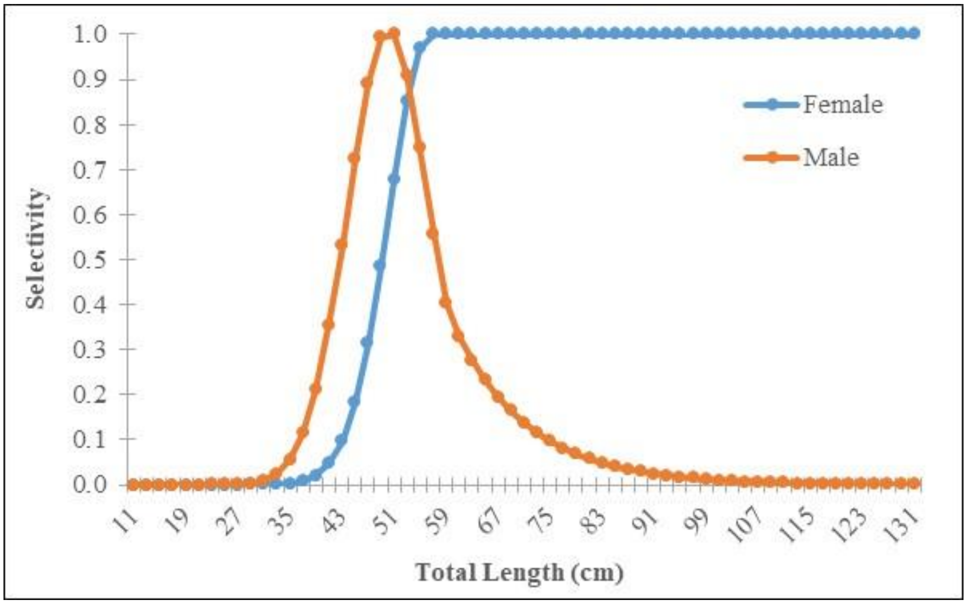

Figure 3.41. Predicted length-based selectivity for the RRef survey from the base run of the stock assessment model.

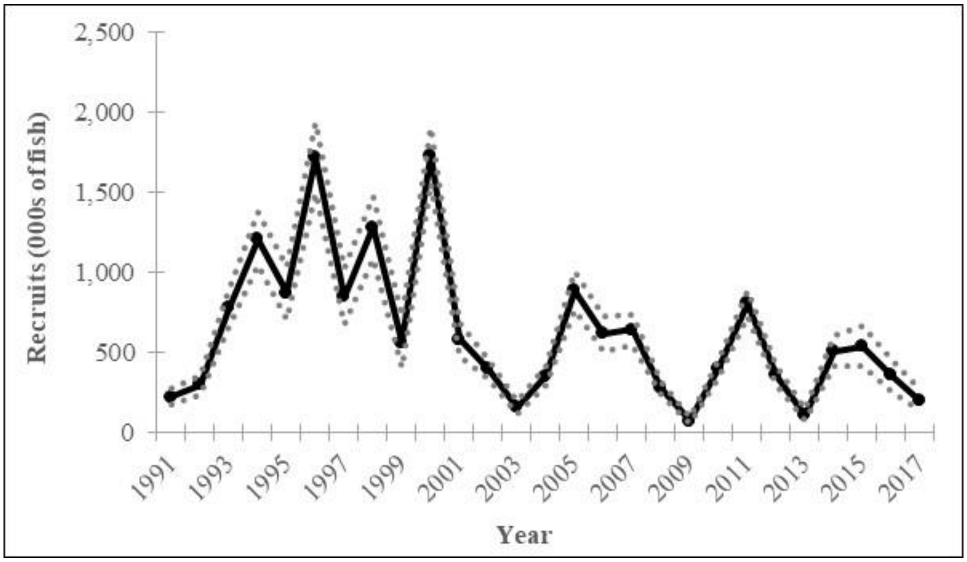

Figure 3.42. Predicted recruitment of age-0 fish from the base run of the stock assessment model, 1991–2017. Dotted lines represent ± 2 standard deviations of the predicted values.

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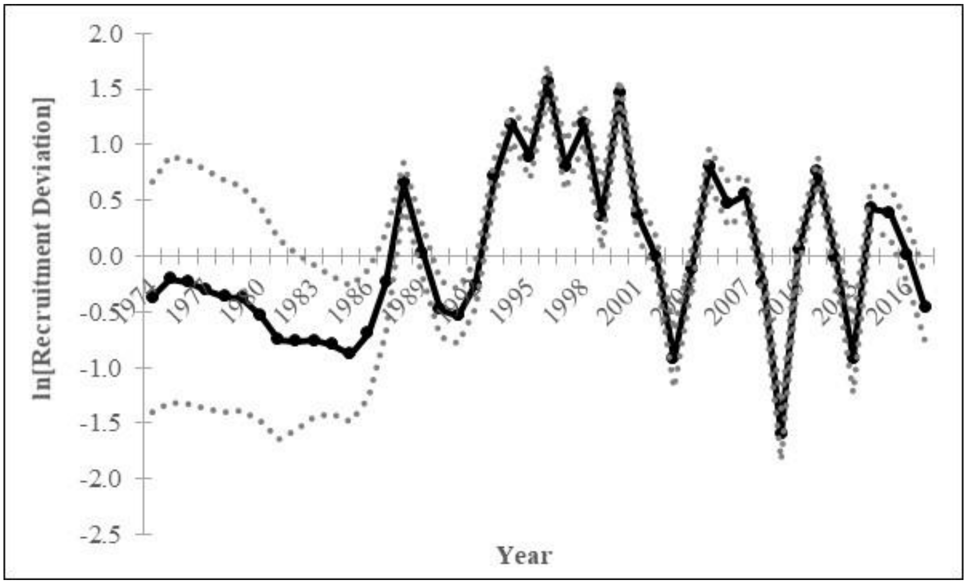

Figure 3.43. Predicted recruitment deviations from the base run of the stock assessment model, 1991–2017. Dotted lines represent ± 2 standard deviations of the predicted values.

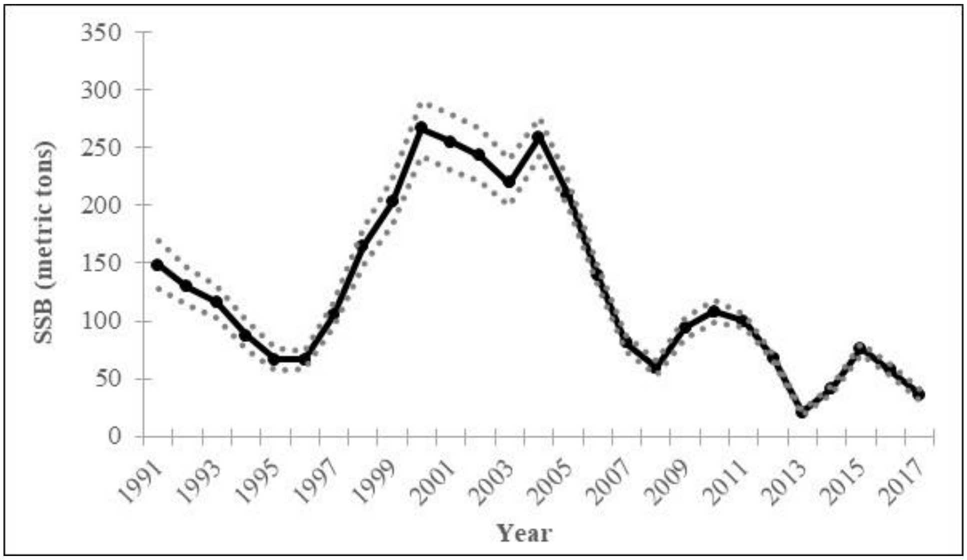

Figure 3.44. Predicted female spawning stock biomass from the base run of the stock assessment model, 1991–2017. Dotted lines represent ± 2 standard deviations of the predicted values.

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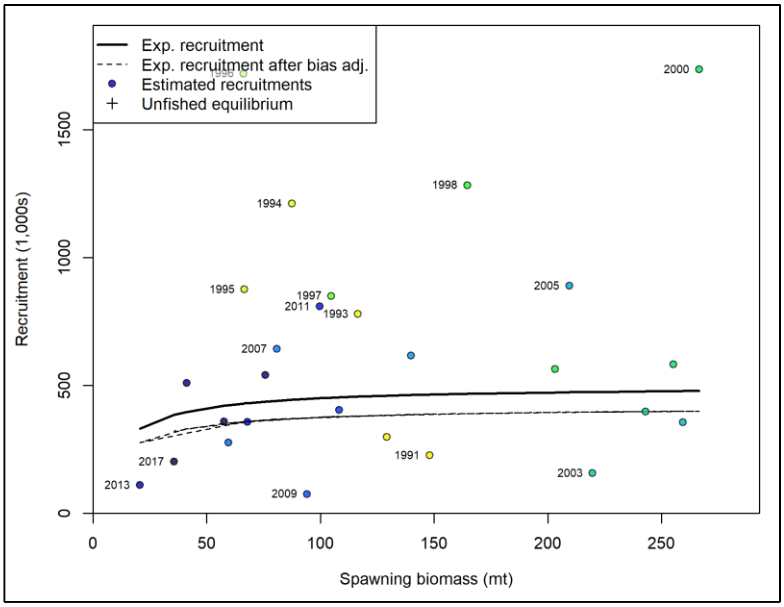

Figure 3.45. Predicted Beverton-Holt stock-recruitment relationship from the base run of the stock assessment model with labels on first (1991), last (2017), and years with (log) deviations > 0.5.

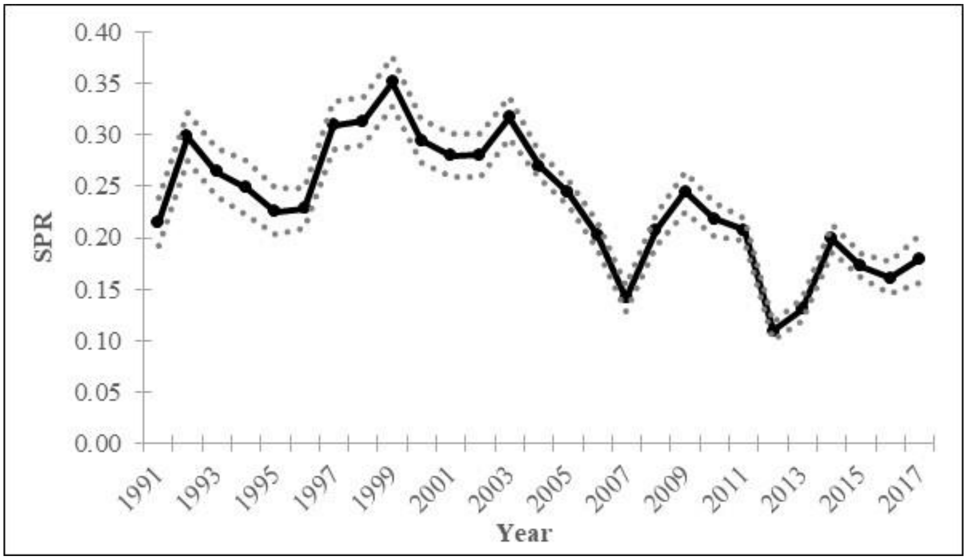

Figure 3.46. Predicted spawner potential ratio (SPR) from the base run of the stock assessment model, 1991–2017. Dotted lines represent ± 2 standard deviations of the predicted values.

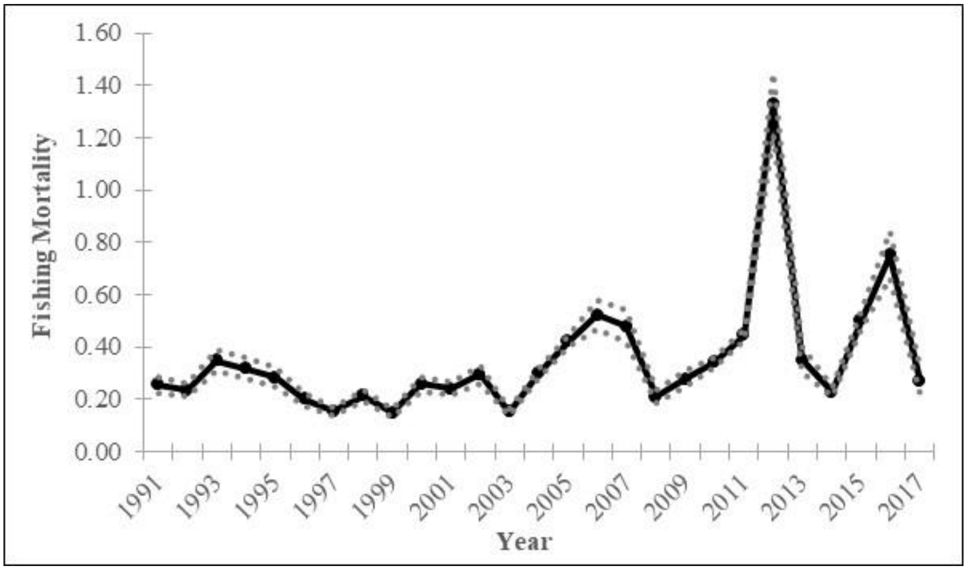

Figure 3.47. Predicted fishing mortality (numbers-weighted, ages 3–5) from the base run of the stock assessment model, 1991–2017. Dotted lines represent ± 2 standard deviations of the predicted values.

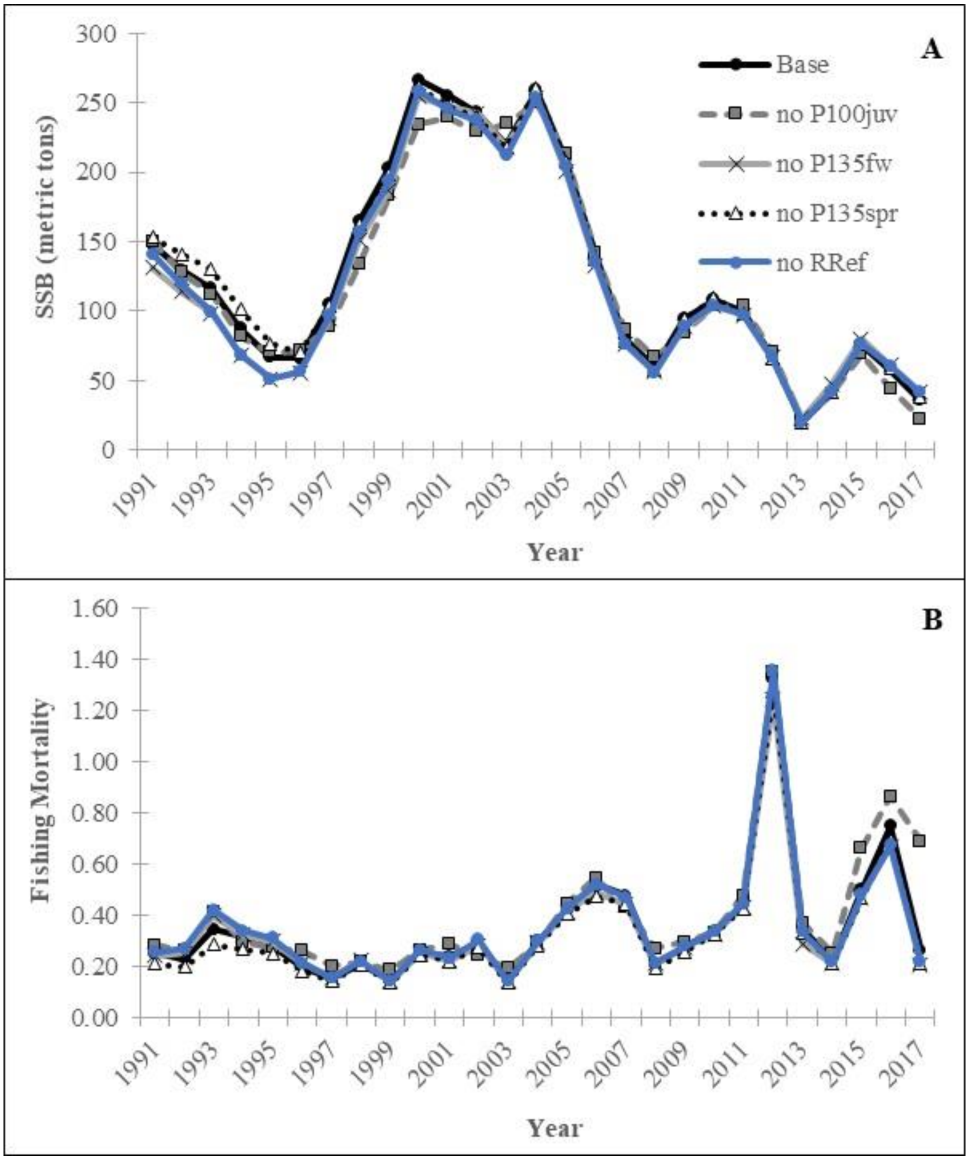

Figure 3.48. Sensitivity of model-predicted (A) female spawning stock biomass (SSB) and (B) fishing mortality rates (numbers-weighted, ages 3–5) to removal of different fisheries-independent survey indices from the base run of the stock assessment model, 1991–2017.

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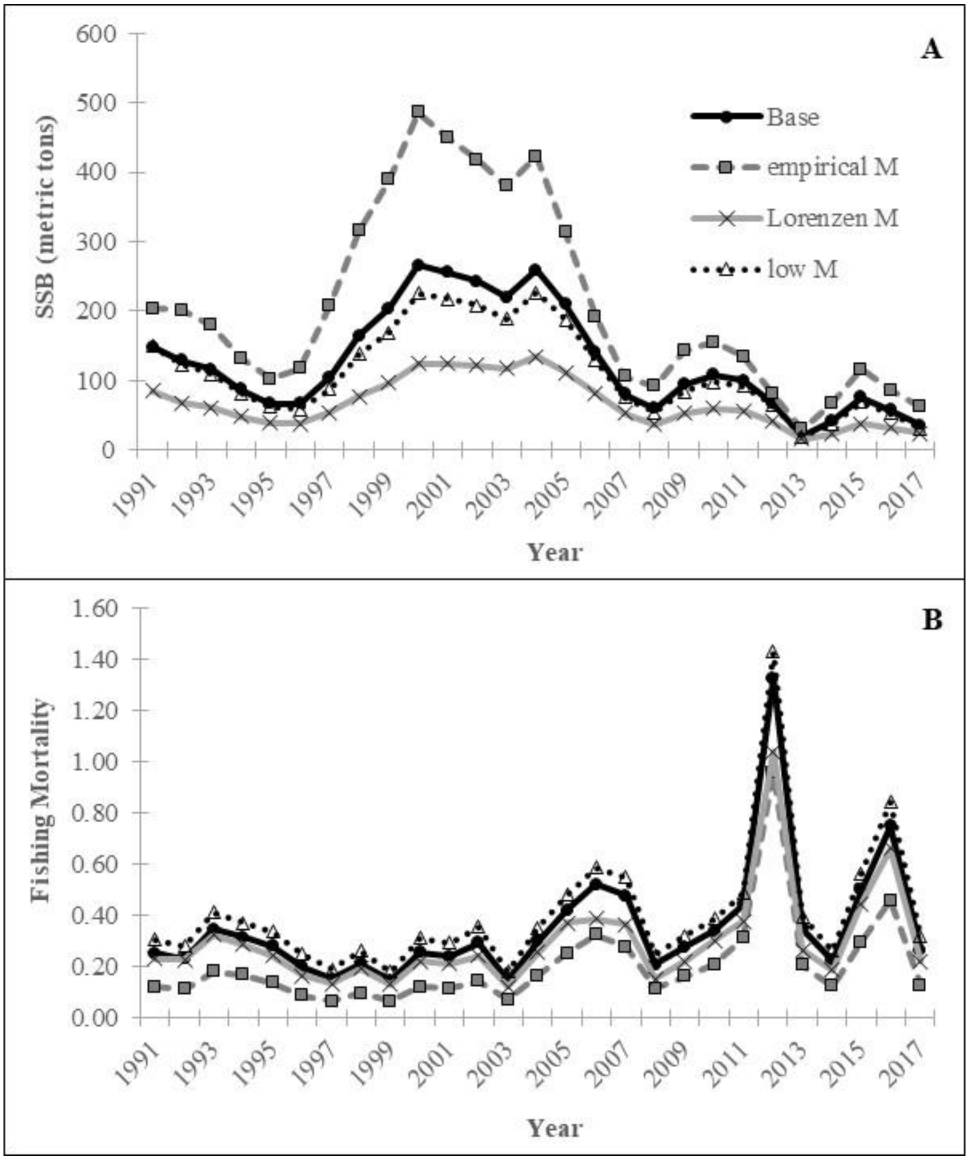

Figure 3.49. Sensitivity of model-predicted (A) female spawning stock biomass (SSB) and (B) fishing mortality rates (numbers-weighted, ages 3–5) to the assumption about natural mortality, 1991–2017.

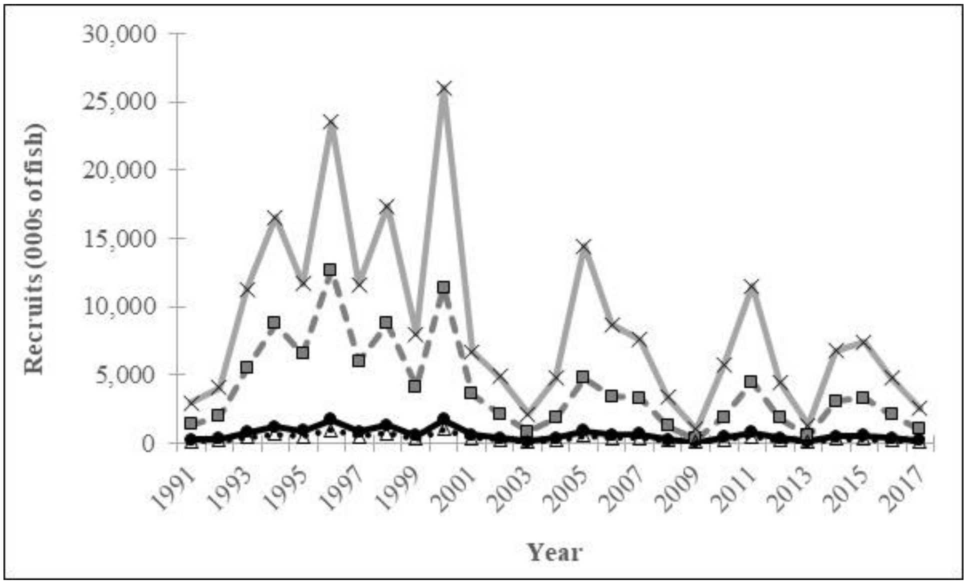

Figure 3.50. Predicted recruitment from the sensitivity runs in which the assumption about natural mortality was changed, 1991–2017.

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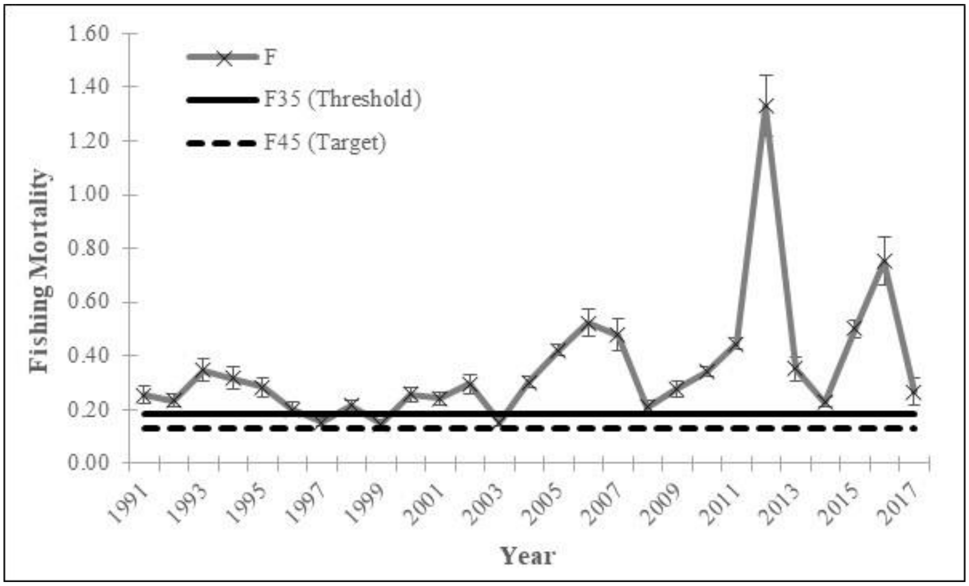

Figure 4.1. Estimated fishing mortality (numbers-weighted, ages 3–5) compared to fishing mortality target ($F_{45\%}$=0.18) and threshold ($F_{35\%}$=0.13). Error bars represent ± two standard errors.

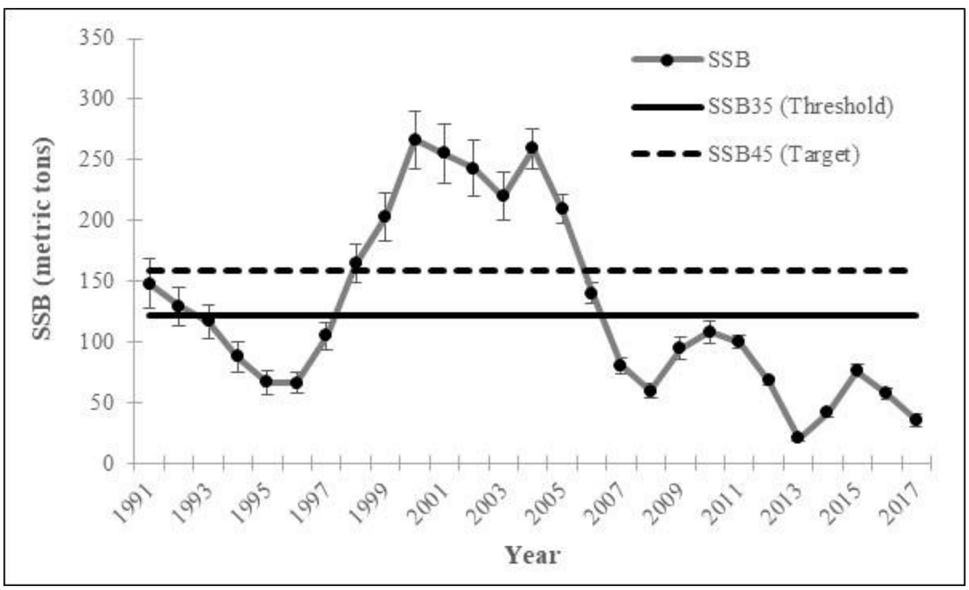

Figure 4.2. Estimated female spawning stock biomass compared to spawning stock biomass target ($SSB_{45\%}$=159 mt) and threshold ($SSB_{35\%}$=121 mt). Error bars represent ± two standard errors.

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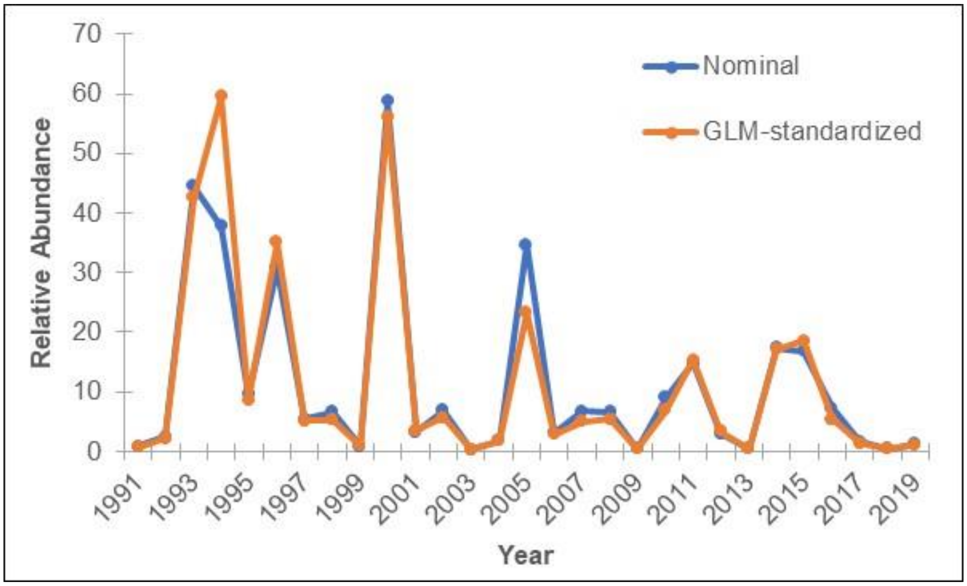

Figure 5.1. Update of the nominal and GLM-standardized indices of relative age-0 abundance derived from the Juvenile Abundance Survey (P100), 1991–2019.

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10 APPENDIX

Addendum to the External Peer Review Report for the 2019 Stock Assessment of the Albemarle Sound-Roanoke River Striped Bass in North Carolina

The SAT was able to satisfactorily resolve several of the RP's concerns in the original base model reviewed during the December 2019 workshop. The growth functions fit to observed length-at-age data external to the assessment model to generate starting values for the assessment model (i.e., empirical growth estimates) showed improved fits to the data and the growth functions predicted by the revised assessment model were more consistent with the empirical growth estimates, particularly for males. Residual patterning from fits to the length composition data in the revised assessment model are still present indicating some model misspecification, but were generally reduced. The corrected P135 indices were more consistent with the decline in recent years observed during the RRef survey, reducing some conflict the original base model was forced to reconcile. It's important to note that the revised model overestimated the index values for both P135 indices and the RRef index during the last three years of the time series, indicating the abundance estimates may still be biased high in these recent years. However, the consistent overfished status determination estimated across the revised model and natural mortality sensitivity runs (see below) lessen this concern.

The revised base model specified an age- and sex-constant natural mortality of 0.72 based on Harris and Hightower (2017). The RP still believes the empirical natural mortality estimates from Harris and Hightower (2017) are higher than reality and suggested sensitivity runs exploring the effects of lower natural mortality rates. The RP was less concerned with variation in natural mortality-at-age, as this can be less influential on parameter bias (Deroba and Schueller 2013) and because model insensitivity to age-specific natural mortality was demonstrated by the SAT in the revised report, and more interested in effects of lower natural mortality for all ages. Therefore, various age-constant life history-based natural mortality estimators were applied to the striped bass data. Ultimately, the Alverson and Carney (1975), Hoenig (1983), and Cubillios et al. (1999) estimators were included in sensitivity runs because they estimated high (relative to the other life history-based estimators, but lower than Harris and Hightower 2017 estimates), moderate, and low natural mortality rates, respectively. Additionally, an average across the estimators, which was slightly lower than the Hoenig (1983) rate, was included in the sensitivity analysis. The SAT conducted a thorough sensitivity analysis of natural mortality with model configurations that included sex-specific and sex-aggregate natural mortality rates with growth fixed or estimated. The sensitivity runs that converged on a solution produced some differences in the scale of estimates, but similar stock trajectories, particularly since the decline in SSB in the mid-2000s (Figures 1-3). The various natural mortality rates had the greatest effect on age-0 recruitment as the model needs to estimate higher recruitment under high mortality scenarios to match the data on subsequent ages that are vulnerable to the fisheries. All sensitivity runs indicated the stock was overfished and experiencing overfishing in the terminal year (Table 1).

The SAT recommended the model with a high, sex-aggregate natural mortality (M=0.40) as the most appropriate to acknowledge estimates from established life history-based methods, but also the higher empirical rates estimated directly from the striped bass population by Harris and Hightower (2017). A sex-aggregate natural mortality rate is consistent with the similar growth estimated between sexes from the available data. Further, a subsequent sensitivity run requested by the RP showed this model configuration is not sensitive to excluding the RRef survey data, as was a primary concern with the original base model. The RP agrees with the SAT's recommendation and recommends this model be used for management advice. The population trajectory and overfished and overfishing stock status estimates from this model are consistent with the available data sets that show poor recruitment in recent years, declining abundance to historically low levels, and a truncated age structure.

Needs for Future Assessments
The RP along with the SAT were collectively concerned about declining recruitment in the time series. One key uncertainty identified in this review is to incorporate the effects of changes in river flow on recruitment. It appears that substantial data exists, but they have not yet been incorporated into the stock assessment. Future assessments should consider key environmental drivers of recruitment such as river flow, because declining recruitment in the time series does not appear to result solely from reduced abundance due to harvest. The RP suggests that future assessments should incorporate flow-recruitment relationships into the stock assessment formally to understand how spring flow conditions influence recruitment and ultimately stock abundance. Another potential influence on the striped bass stock is the prevalence of non-native catfishes, primarily blue catfish *Ictalurus furcatus* and flathead catfish *Pylodictis olivaris*. Both species occur in North Carolina river systems and it seems the blue catfish population is expanding in the Roanoke River and Albemarle Sound areas. Predation by catfishes could potentially impact recruitment of striped bass directly, or could influence food resources for striped bass through competition for prey (e.g., Pine et al. 2005). The degree to which this occurs is not known, but future assessments should consider this as a factor that may influence abundance and is not tied to striped bass harvest.

Moderate and evident differences in growth (Figures 1.2 and 1.3, main report) are not resolved within the model. The effect on estimation of sex-specific M are not readily quantifiable at present. Factors potentially contributing to the poor resolution of male and female growth trajectories, as estimated by the von Bertalanffy growth function, include under-representation of older age classes and lack of sex-specific length data for Ages 0 to 2^{+} year old fish. The RP accordingly encourages collection of sex-specific length-at-age data from juveniles (ages 0–2) and as well from older fish to better inform growth estimates.

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Hoenig, J. 1983. Empirical use of longevity data to estimate mortality rates. Fishery Bulletin 81(4): 898–903.

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Tables

Table 1. Specified natural mortality, terminal year and threshold model estimates, and stock status across the revised base model (Baseline) and natural mortality sensitivity runs. The RP recommends the "highMsamesex (est growth)" run be used for a management advice.

Scenario	M (yr^{-1})	Current year (2017)		Threshold		Overfished	Overfishing	Reference
		SSB (mt)	F (yr^{-1})	$SSB_{35\%}$ (mt)	$F_{35\%}$ (yr^{-1})			
Baseline	0.72	62	0.13	89	0.43	Y	N	Harris and Hightower, 2017
avgM (est growth)	0.23F, 0.25M	30.80	0.35	283.88	0.12	Y	Y	
avgM (fix growth)	0.23F, 0.25M	47.46	0.28	153.20	0.13	Y	Y	
midM (fix growth)	0.25F, 0.28M	42.79	0.29	114.46	0.14	Y	Y	Hoenig 1983
highM (fix growth)	0.37F, 0.44M	40.22	0.31	182.06	0.19	Y	Y	Alverson and Camey 1975
highMsamesex (est growth)	0.40	35.64	0.27	121.29	0.18	Y	Y	Alverson and Camey 1975
avgMsamesex (est growth)	0.24	32.91	0.28	150.77	0.11	Y	Y	

Figures

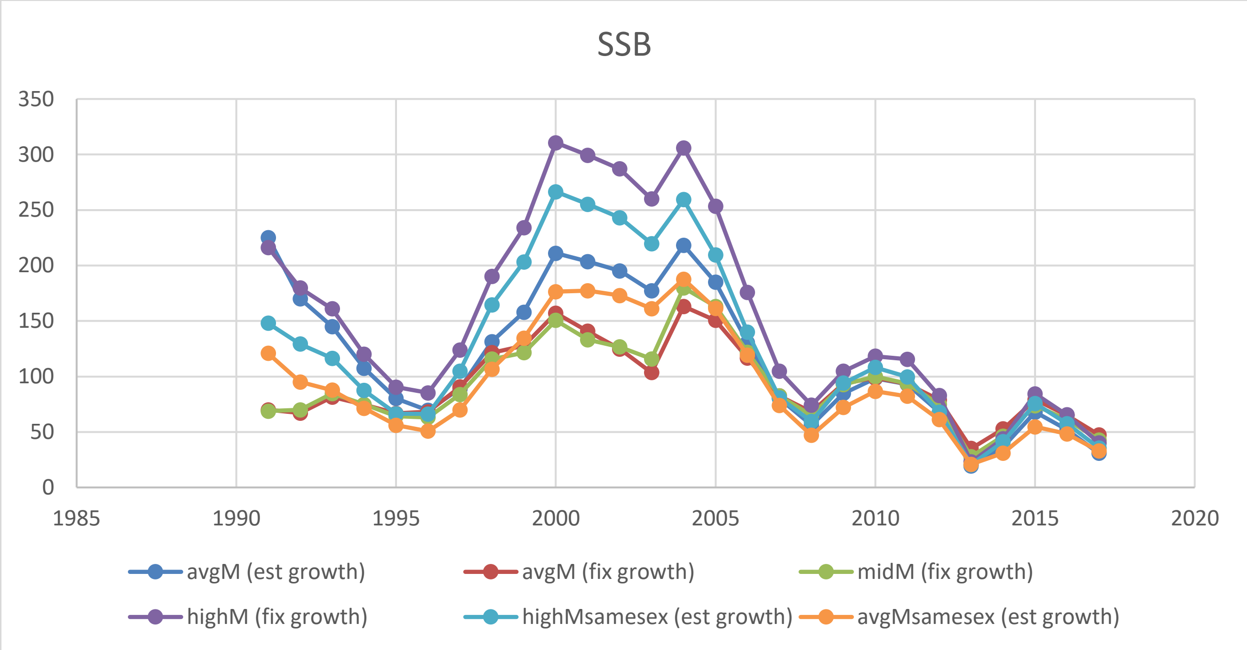

Figure 1. Female spawning stock biomass estimates (metric tons) across natural mortality sensitivity runs.

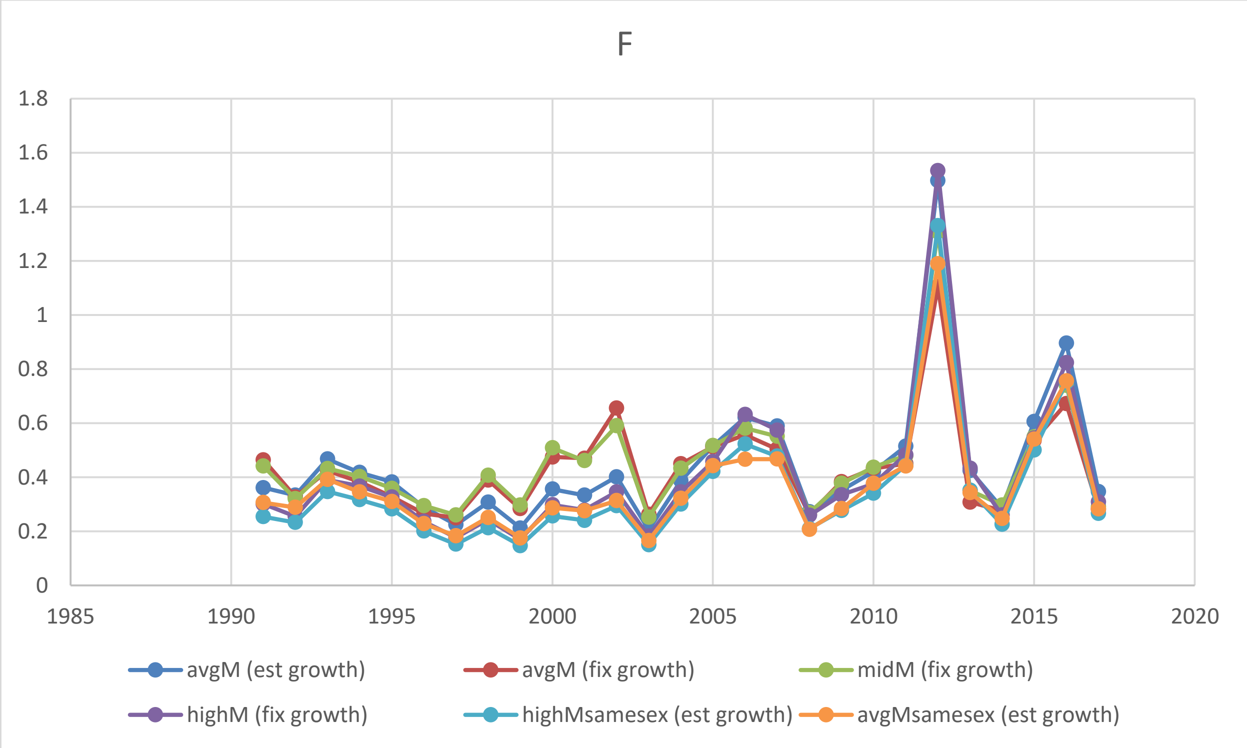

Figure 2. Numbers-weighted ages 3-5 average fishing mortality estimates across natural mortality sensitivity runs.

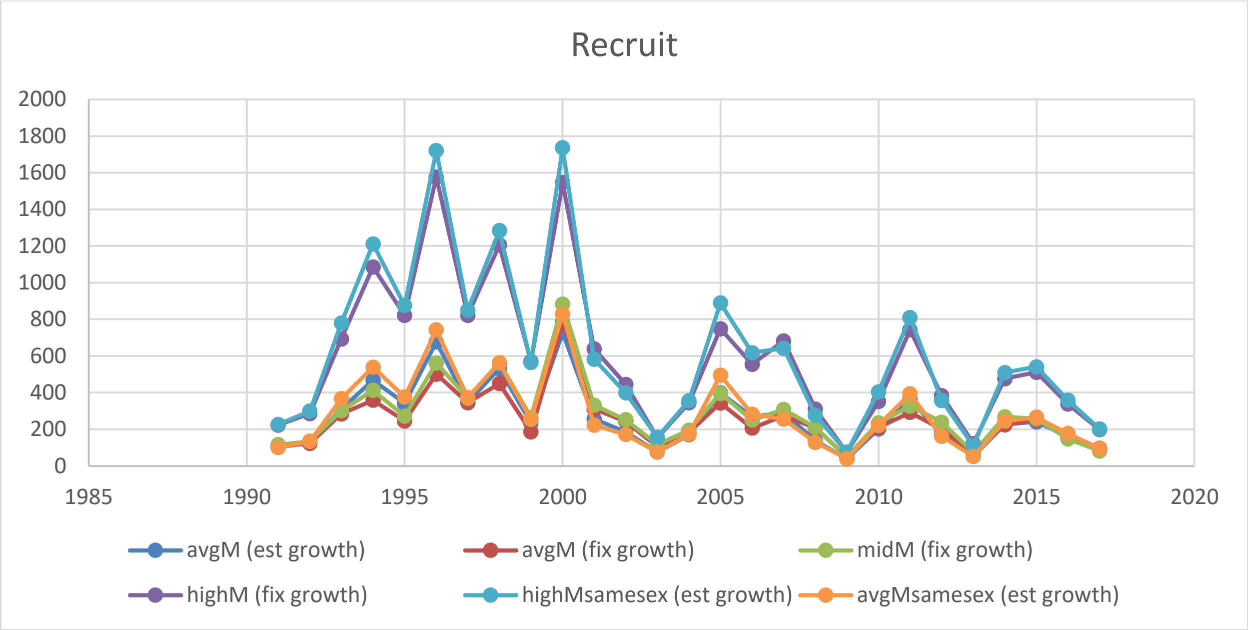

Figure 3. Age-0 recruitment estimates (thousands) across natural mortality sensitivity runs.

November 2020 Revision

to

Amendment 1

to the

North Carolina Estuarine Striped Bass Fishery Management Plan

Prepared By The

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November 2020 Revision

to

Amendment 1

to the

North Carolina Estuarine Striped Bass

Fishery Management Plan

Effective Jan. 1, 2021

I. ISSUE

Requirement to reduce the striped bass total allowable landings (TAL) in the Albemarle Sound and Roanoke River Management Areas to remain in compliance with Amendment 1 to the North Carolina Estuarine Striped Bass Fishery Management Plan (FMP) and the Atlantic States Marine Fisheries Commission (ASMFC) Addendum IV to Amendment 6 to the Interstate FMP for Atlantic Striped Bass. The reduction in TAL is required based on results of the 2020 Albemarle-Roanoke (A-R) striped bass benchmark stock assessment that indicates the stock is overfished and overfishing is occurring in the terminal year (2017) of the assessment (Lee et al. 2020).

II. ORIGINATION

North Carolina Division of Marine Fisheries (NCDMF) staff and North Carolina Wildlife Resources Commission (NCWRC), Inland Fisheries Division staff.

III. BACKGROUND

Atlantic striped bass from Maine through North Carolina are managed under the jurisdiction of the ASMFC since Congress passed the Atlantic Striped Bass Conservation Act in 1984. The A-R striped bass stock is migratory at older ages but contributes minimally to the overall Atlantic striped bass stock complex compared to the Chesapeake Bay, Delaware, and Hudson stocks (ASMFC 2003; Berggren and Lieberman 1978; Callihan et al. 2014). Due to the non-migratory behavior of striped bass stocks south of the Albemarle Sound Management Area (ASMA), the striped bass stocks within the Central Southern Management Area (CSMA) are not included in ASMFC's Interstate FMP for Atlantic striped bass.

The ASMFC Atlantic Striped Bass Management Board approved Addendum IV to Amendment 6 to the Interstate FMP for Atlantic Striped Bass in October 2014 (ASMFC 2014). Through this addendum the ASMFC Atlantic Striped Bass Technical Committee determined it was most biologically appropriate to use NCDMF's A-R stock assessment to determine appropriate fishing mortality (*F*) and spawning stock biomass (SSB) biological reference points (BRPs) specifically for the A-R stock rather than using the same BRPs as the Chesapeake Bay.

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Future A-R benchmark stock assessments and updates will recalculate BRPs accordingly based on additional years of harvest, discard data, and indices of relative abundance added to the model. The ASMFC Atlantic Striped Bass Technical Committee and Management Board will continue to review each NCDMF A-R striped bass benchmark stock assessment for approval for management use as a point of compliance.

The 2020 A-R striped bass benchmark stock assessment was conducted to inform development of Amendment 2 to the North Carolina Estuarine Striped Bass FMP, which is currently underway. The A-R stock assessment is periodically undertaken for management purposes to reassess the stock status relative to the BRPs. This is generally undertaken when the ASMFC Striped Bass Technical Committee assesses the coast-wide stock or when the NCDMF initiates an amendment to the North Carolina Estuarine Striped Bass FMP.

The 2020 A-R striped bass benchmark stock assessment was completed in August 2020 (Lee et al. 2020). The assessment went through a multi-day peer review process in which NCDMF staff presented the assessment to three external experts on striped bass and marine fisheries modeling techniques. The external peer review is the standard process to review marine fisheries stock assessments throughout the world. The 2020 benchmark assessment was approved for management use by the peer reviewers for at least the next five years. The NCDMF also approved it for management use.

Results from the 2020 benchmark assessment indicate the A-R striped bass stock is overfished and overfishing is occurring relative to the updated BRPs, which are based on spawning potential ratio (SPR) thresholds of $F_{35\%SPR}$ and $SSB_{35\%SPR}$ and targets of $F_{45\%SPR}$ and $SSB_{45\%SPR}$ (Table 1) (Lee et al. 2020). The F estimate in the terminal year (2017) of the assessment was 0.27, above the $F_{35\%SPR\ Threshold}$ of 0.18, meaning overfishing is occurring. Female SSB was estimated at 78,576 lb, below the $SSB_{35\%SPR\ Threshold}$ of 267,390 lb, indicating the stock is overfished (Table 1). Adaptive management measures in Amendment 1 to the North Carolina Estuarine Striped Bass FMP (NCDMF 2013) are a mechanism to maintain a sustainable harvest. Sustainable harvest is defined in North Carolina General Statute 113-129(14a) as "the amount of fish that can be taken from a fishery on a continuing basis without reducing the stock biomass of the fishery or causing the fishery to become overfished." With overfishing occurring in the terminal year of the assessment (2017), adaptive management measures contained in Amendment 1 are required to be implemented to reduce the TAL to a level that is projected to lower F to the $F_{45\%SPR\ Target}$, a 47.6 % reduction in F (Table 1) (NCDMF 2013). This action maintains compliance with Amendment 1 to the North Carolina Estuarine Striped Bass FMP and ASMFC's Addendum IV to Amendment 6 to the Interstate FMP for Atlantic Striped Bass.

Until adoption of Amendment 2 or another revision, the A-R striped bass stock is managed through Amendment 1 to the North Carolina Estuarine Striped Bass FMP and the November 2014 Revision to Amendment 1. The following management strategies are in place for the ASMA and RRMA by these documents:

Strategies currently in place under the November 2014 Revision to Amendment 1 and Amendment 1 to the North Carolina Estuarine Striped Bass FMP:

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A-R stock has been managed with a TAL since 1991

- Maintain current TAL of 275,000 lb
- The TAL will continue to be split evenly between commercial and recreational sectors
- ASMA commercial TAL = 137,500 lb
- ASMA recreational TAL = 68,750 lb
- RRMA recreational TAL = 68,750 lb

ASMA Commercial Harvest (TAL = 137,500 lb)

- 18-inch total length (TL) minimum size limit (ASMFC compliance requirement)
- Continue to operate as a bycatch fishery
- Spring season, anytime between Jan. 1–April 30
- Fall season, anytime between Oct. 1–Dec. 31
- Daily trip limits for striped bass
- Maintain gill-net mesh size and yardage restrictions
- Maintain seasonal and area closures
- Maintain attendance requirements for small mesh nets (mid-May through late November)

ASMA Recreational Harvest (TAL = 68,750 lb)

- 18-inch TL minimum size limit
- Daily creel limit (can be adjusted as necessary to keep harvest below the TAL)
- Open 7 days a week all season (can be adjusted as necessary to keep harvest below the TAL)
- Spring season, anytime between Jan. 1–April 30
- Fall season, anytime between Oct. 1–Dec. 31

RRMA Recreational Harvest (TAL = 68,750 lb)

- 18-inch TL minimum size limit
- Protective slot (no harvest): 22–27 inches TL
- 2 fish daily creel, only one of which can be greater than 27 inches TL
- Harvest season in entire river opens on March 1 and closes on April 30 by rule since 2008
- Single barbless hook regulation from April 1–June 30 in Inland waters above the US 258 Bridge

Management of TALs for ASMA and RRMA

- BRPs (*F* and SSB) for the A-R stock will be determined through North Carolina A-R striped bass benchmark stock assessments, which must be approved by the ASMFC Atlantic Striped Bass Management Board
- Short-term Overages: if the harvest point estimate exceeds the total TAL by 10% in a single year, overage is deducted from the next year and restrictive measures implemented in the responsible fishery(ies)
- Long-term Overages: five-year running average of harvest point estimate exceeds the five-year running average of the total TAL harvest by 2%, the responsible fishery exceeding the harvest limit will be reduced by the amount of the overage for the next five years. **Should the target *F* be exceeded, then restrictive measures will be imposed to reduce *F* to the target level**

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IV. AUTHORITY

North Carolina's existing fisheries management system is powerful and flexible, with rule-making authority granted to the North Carolina Marine Fisheries Commission (NCMFC) and the NCWRC within their respective jurisdictions. Further, the NCMFC has delegated specified proclamation authority to the NCDMF Director in its rules. The NCWRC has authority to issue limited proclamations and may delegate this authority to the NCWRC Executive Director.

Proclamation Authority for the ASMA, RRMA, and CSMA striped bass stocks:

The NCMFC can regulate fishing times, areas, fishing gear, seasons, size limits, and quantities of fish harvested and possessed in joint and coastal waters (G.S. 113-182 and 143B-289.52). The NCMFC can delegate the authority to implement its regulations for fisheries as set forth in NCMFC rules "which may be affected by variable conditions" to the Director of the NCDMF who may then issue public notices called "proclamations" (G.S. 113-221.1 and 143B-289.52). The NCWRC has authority to license and regulate all fishing activities in inland waters, and the NCWRC also has proclamation authority, which may be delegated to the Executive Director, to suspend or extend seasons for taking of striped bass in inland and joint waters of coastal rivers and their tributaries (G.S. 113-292). Thus, all necessary authority needed for management of the striped bass fisheries is available through the existing state fishery management process.

It should also be noted that under the provisions of the North Carolina Estuarine Striped Bass FMP Amendment 1 the NCDMF Director maintains proclamation authority to establish seasons, authorize or restrict fishing methods and gear, limit quantities taken or possessed, and restrict fishing areas as deemed necessary to maintain a sustainable harvest. The NCWRC Executive Director maintains proclamation authority to establish seasons.

N.C. General Statutes

G.S. 113-134.	RULES
G.S. 113-182.	REGULATION OF FISHING AND FISHERIES
G.S. 113-182.1.	FISHERY MANAGEMENT PLANS
G.S. 113-221.1.	PROCLAMATIONS; EMERGENCY REVIEW
G.S. 113-292.	AUTHORITY OF THE WILDLIFE RESOURCES COMMISSION IN REGULATION OF INLAND FISHING AND THE INTRODUCTION OF EXOTIC SPECIES.
G.S. 143B-289.52.	MARINE FISHERIES COMMISSION—POWERS AND DUTIES

N.C. Marine Fisheries Commission Rules 2020 and N.C. Wildlife Resources Commission Rules 2020 (15A NCAC)

15A NCAC 03M .0201	GENERAL
15A NCAC 03M .0202	SEASON, SIZE AND HARVEST LIMIT: INTERNAL COASTAL WATERS
15A NCAC 03M .0512	COMPLIANCE WITH FISHERY MANAGEMENT PLANS
15A NCAC 03Q .0107	SPECIAL REGULATIONS: JOINT WATERS

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15A NCAC 03Q .0108	MANAGEMENT RESPONSIBILITY FOR ESTUARINE STRIPED BASS IN JOINT WATERS
15A NCAC 03Q .0109	IMPLEMENTATION OF ESTUARINE STRIPED BASS MANAGEMENT PLANS: RECREATIONAL FISHING
15A NCAC 03R .0201	STRIPED BASS MANAGEMENT AREAS
15A NCAC 10C .0110	MANAGEMENT RESPONSIBILITY FOR ESTUARINE STRIPED BASS IN JOINT WATERS
15A NCAC 10C .0111	IMPLEMENTATION OF ESTUARINE STRIPED BASS MANAGEMENT PLANS: RECREATIONAL FISHING
15A NCAC 10C .0301	INLAND GAME FISHES DESIGNATED
15A NCAC 10C .0314	STRIPED BASS

V. DISCUSSION

Results from the 2020 A-R striped bass benchmark stock assessment indicate the stock is overfished and overfishing is occurring (Lee et. al 2020). The estimate of F in the terminal year of the assessment (2017) was 0.27, above the $F_{35\%SPR\ Threshold}$ of 0.18 (Figure 1) and the estimate of SSB was 78,576 lb, below the $SSB_{35\%SPR\ Threshold}$ of 267,390 lb (Figure 2). Estimates of F have been above the $F_{35\%SPR\ Threshold}$ in 24 out of the 27 years of the time period of the assessment (Figure 1). Female SSB has declined steadily from a high of 587,516 lb in 2000 to a low of 45,418 lb in 2013. Female SSB increased through 2015 to 167,053 lb and has declined since (Figure 2). Results of the assessment also show a period of strong recruitment (as measured by the number of age-0 fish coming into the stock each year) from 1993 to 2000, then a period of much lower recruitment from 2001 to 2017, which has contributed to the decline in SSB since 2003. Average recruitment from 1993-2000 was 1,127,646 age-0 fish per year while average recruitment for years 2001-2017 was 428,796 age-0 fish per year (Figure 2).

Several years of poor recruitment occurred from 2001–2004 at a time when SSB was at high levels, indicating factors other than abundance of SSB may be contributing to poor spawning success in some years. Appropriate river flow during the spawning period has long been recognized as an important factor in spawning success for A-R striped bass (Hassler et. al 1981; Rulifson and Manooch 1990). Low to moderate flows have been identified as favorable to strong year-class production while high flows (10,000 cubic feet per second or greater) are unfavorable to the formation of strong year classes. The peer reviewers of the 2020 benchmark assessment recognized the importance of river flow on recruitment and noted declining recruitment in the time series does not appear to result solely from reduced abundance due to harvest (Lee et. al 2020).

Concerning trends are also evident in all the juvenile and adult fishery-independent surveys of relative abundance conducted by the NCDMF and NCWRC to monitor the A-R striped bass stock. Both NCDMF gill-net surveys and the NCWRC electrofishing survey show declining trends, especially in the number of older fish, in recent years below levels of abundance observed when the stock was severely depressed in the early 1990s. Harvest from all sectors since about 2005 have shown similar declining trends as total abundance estimates from the stock assessment, which indicate a declining trend in total abundance since the early 2000s (Figures 1 and 3).

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Since the TAL increase to 550,000 lb in 2003 (Table 2, Figure 3), total combined landings from all fisheries in the ASMA and RRMA have not exceeded 460,853 lb and have averaged 235,278 lb per year with a low of 108,432 lb in 2013 (Figure 3). For the years 2005–2013, the commercial sector did not reach their TAL. Estimates of total abundance from the stock assessment (Figure 1), suggest the reason for the decline in harvest was likely a decline in overall stock abundance due to poor recruitment (Figure 2). Even since the 2014 reduction in the TAL to 275,000 lb the commercial and recreational sectors in the ASMA did not reach the TAL from 2014–2017. Harvest in all sectors has increased since 2017, with the commercial sector reaching the TAL in 2019 causing the NCDMF to close the fall commercial harvest season before Dec. 31 for the first time since 2010. This increase in harvest is likely due to the above-average year classes produced in 2014 and 2015 (Figure 2). The fisheries are primarily composed of fish age 3–6 so the indication of good recruitment in the fishery as seen in landings is offset by 2–4 years as the new recruits grow and begin to enter the fisheries.

Since the early 2000s the recreational sectors have only approached their TAL in 2015 and 2016 (Figure 3). Harvest in the recreational sectors consists primarily of fish age 3–5. Even with an increase in the daily creel limit in the ASMA from two fish per person per day to three fish per person per day in the fall of 2006 through the fall of 2015, harvest was still below the TAL in all years except 2015. The daily creel limit was reduced back to two fish per person per day in the spring of 2016.

Recreational harvest in the RRMA is more controlled by the daily creel limit than in the ASMA. The Roanoke River is a smaller body of water and striped bass congregate in large numbers throughout the river on their way to and while on the spawning grounds. Because the fish are moving through the system for spawning activity in a more compressed area, recreational anglers tend to release more legal sized fish than anglers in the ASMA. An increase in the daily creel limit in the RRMA to more than two fish per person per day would likely result in the TAL being exceeded in most years in the RRMA.

Reductions in the TAL to lower *F* to the target reference point value

Adaptive management in Amendment 1 to the North Carolina Estuarine Striped Bass FMP states "should the target *F* be exceeded, then restrictive measures will be imposed to reduce *F* to the target level". Amendment 1 does not specify a time frame to bring *F* back to the target. Total removals in 2017 included 119,244 lb of harvest and 23,795 lb of dead discards. Assuming the same level of discards, landings will need to be reduced by 57% compared to 2017 landings to lower *F* to the target of $F_{45\%SPR}$ of 0.13. This 57% reduction from 2017 landings equates to a new overall TAL of 51,216 lb. for the ASMA and RRMA. As with all fisheries, the A-R stock recovery under the new TAL is subject to other factors. Future spawning success and subsequent recruitment levels are the main area of uncertainty. If the stock experiences even a few good years of recruitment, stock abundance can increase quickly under low levels of harvest. Given the new TAL reflects the target *F* reference point and not the threshold *F*, it does provide some amount of buffer for changing circumstances and provides a constant level of constrained harvest while Amendment 2 is developed to address long-term management needs.

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There are several management measures available through proclamations or rules that allow the NCDMF and NCWRC to keep harvest levels below the proposed TAL in the ASMA and RRMA. For the commercial fishery these include daily reporting of landings by striped bass dealers for daily monitoring of harvest, mandatory tagging of all striped bass sold, adjusting the daily possession limit, adjusting the opening and closing of the season, area closures, and gill-net yardage restrictions. For the ASMA and RRMA recreational fisheries, measures include a creel survey that allows for weekly estimates of harvest, adjusting the daily possession limit, adjusting the allowable harvest days during the open season, adjusting the opening and closing of the season, and area closures.

Starting in January 2021 the above-mentioned management measures will be used to keep harvest below the newly reduced TAL.

The NCDMF and NCWRC members of the FMP Plan Development Team met several times to discuss the issues outlined in this document, and based on those discussions, agreed to set the new TAL for the A-R striped bass stock at 51,216 lb. The following section serves to revise Amendment 1 to the North Carolina Estuarine Striped Bass FMP to reflect the new TAL that will lower *F* to the target level.

VI. TOTAL ALLOWABLE LANDINGS MANAGEMENT REVISION TO AMENDMENT 1 TO THE NORTH CAROLINA ESTUARINE STRIPED BASS FMP

Amendment 1 to the North Carolina Estuarine Striped Bass FMP, in conjunction with the North Carolina FMP for Interjurisdictional Fisheries, provides the framework for the changes in management proposed herein. This document will be incorporated as the November 2020 Revision to Amendment 1 to the North Carolina Estuarine Striped Bass FMP, and replaces the November 2014 Revision to Amendment 1 to the North Carolina Estuarine Striped Bass FMP. It will serve to document the rationale agreed to by the NCDMF and NCWRC for the following management strategy to begin Jan. 1, 2021 and continue until the adoption of Amendment 2.

- Biological Reference Points (*F* and SSB) for the A-R stock will be determined through North Carolina A-R striped bass benchmark stock assessments and updates
- Benchmark assessments will be reviewed by the ASMFC Striped Bass Management Board for approval
- Set the TAL for the A-R stock at 51,216 lb, to be split evenly between the commercial and recreational sectors as follows:
    - ASMA commercial TAL = 25,608 lb
    - ASMA recreational TAL = 12,804 lb
    - RRMA recreational TAL = 12,804 lb

All other management strategies contained in Amendment 1 will remain in force until another North Carolina Estuarine Striped Bass FMP revision is implemented or amendment is adopted.

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Table 1. Biological reference points for the Albemarle-Roanoke striped bass stock and the point estimate from the terminal year (2017) of the assessment. Source: Lee et al. 2020

Biological Reference Points		Terminal Year (2017) Estimate
$F_{45\%SPR\ Target}$	0.13	$F = 0.27$
$F_{35\%SPR\ Threshold}$	0.18	
$SSB_{45\%SPR\ Target}$	350,371 lb	SSB = 78,576 lb
$SSB_{35\%SPR\ Threshold}$	267,390 lb	

Table 2. Total allowable landings (lb) for the Albemarle-Roanoke striped bass stock, 1991–2019.

Years	Total Allowable Landings	ASMA Commercial	ASMA Recreational	RRMA Recreational
1991–1997	156,800	98,000	29,400	29,400
1998	250,800	125,400	62,700	62,700
1999	275,880	137,940	68,970	68,970
2000–2002	450,000	225,000	112,500	112,500
2003–2014	550,000	275,000	137,500	137,500
2015–2019	275,000	137,500	68,750	68,750

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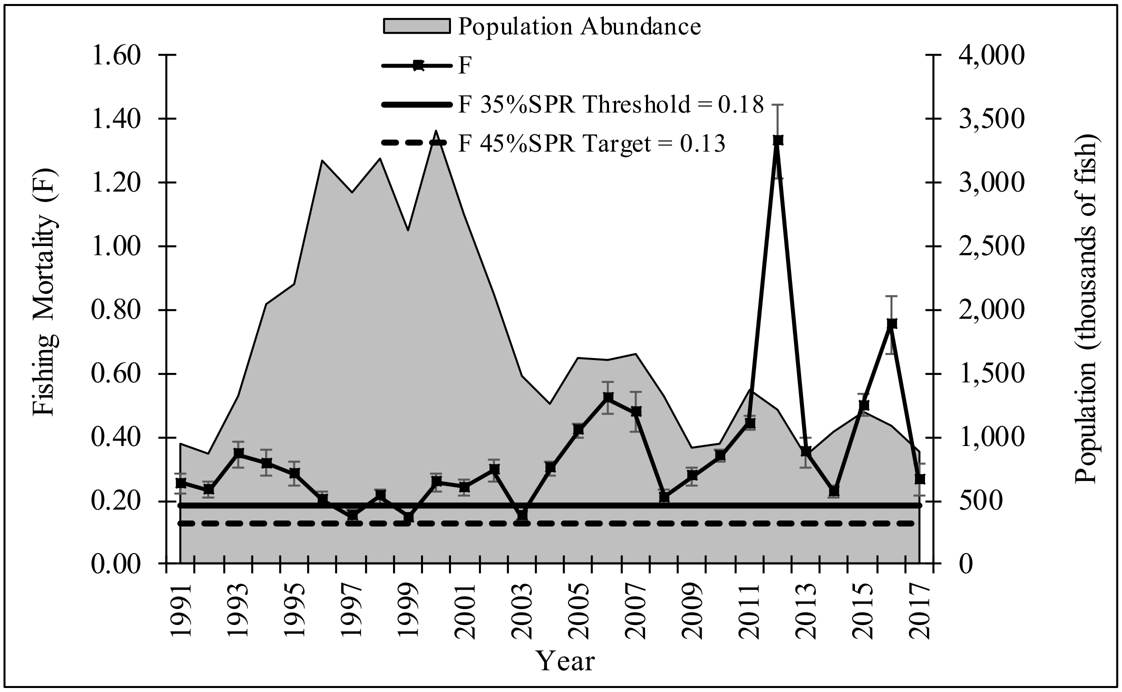

Figure 1. Estimates of fishing mortality (F) and population abundance for the Albemarle-Roanoke striped bass stock, 1991–2017. Source: Lee et al. 2020

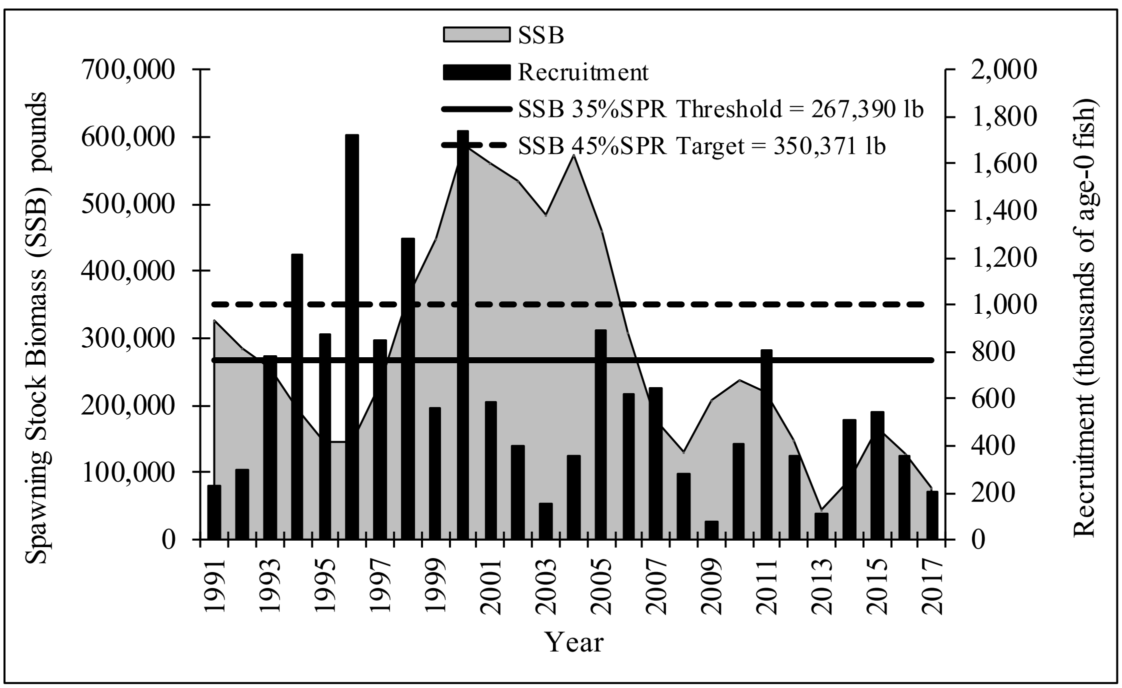

Figure 2. Estimates of spawning stock biomass (SSB) and recruitment of age-0 fish coming into the population each year for the Albemarle-Roanoke striped bass stock, 1991–2017. Source: Lee et al. 2020

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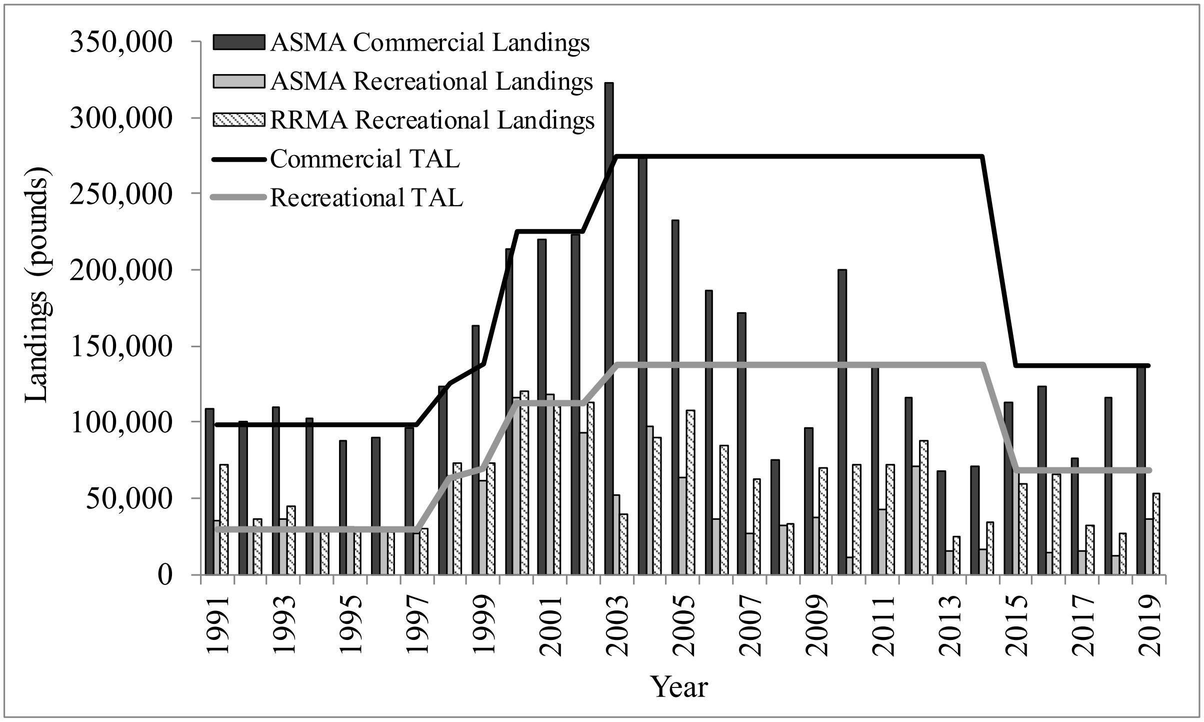

Figure 3. Striped bass landings from the Albemarle Sound Management Area commercial and recreational sectors and Roanoke River Management Area recreational sector and the total allowable landings, 1991–2019.

VII. REFERENCES CITED

Atlantic States Marine Fisheries Commission (ASMFC). 2003. Amendment # 6 to the interstate fishery management plan for Atlantic striped bass. ASMFC, Fisheries Management Report No. 41, Washington, DC. 63 p.

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Scoping Document

Photo By: Buzz Bryson

Striped bass spawning in the Roanoke River, Weldon, NC

Management Strategies for

Amendment 2 to the North Carolina Estuarine Striped Bass Fishery Management Plan

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Photo By: Jesse Bissette

Can't attend but want to submit comments? Here's how!

Written comments can be submitted by online form or by U.S. mail. Comments sent by U.S. mail must be received by Nov. 15, 2020 to be accepted. The division will not accept public comment through email.

To comment by online form:

The online form can be accessed through the N.C. Estuarine Striped Bass Amendment 2 Information Page (http://portal.ncdenr.org/web/mf/striped-bass-amendment-topic). Please use the link at the bottom of the information page.

To comment by U.S. mail, please submit written comments to:

N.C. Division of Marine Fisheries
N.C. Estuarine Striped Bass
FMP Amendment 2
Scoping Comments
P.O. Box 769
Morehead City, NC 28557

The N.C. Division of Marine Fisheries seeks your input on management strategies for the Estuarine Striped Bass Fishery Management Plan.

A scoping period for public comment begins Nov. 2, 2020 and ends Nov. 15, 2020.

Comments must be received by 5 p.m. (EST) on Nov. 15, 2020.

Scoping Meetings

DMF staff will provide information about Amendment 2 to the N.C. Estuarine Striped Bass FMP. A public comment period will follow.

The public may participate in the meeting online or by telephone. To facilitate comments, the division is asking those who wish to speak during the meeting to pre-register.

Links to scoping information, including registration to speak, webinar instructions, the call-in telephone number, and other references, can be found through the N.C. Estuarine Striped Bass Amendment 2 Information Page (http://portal.ncdenr.org/web/mf/striped-bass-amendment-topic).

Thursday, Nov. 5, 2020: 6 p.m. to 8 p.m.

https://ncdenrits.webex.com/ncdenrits/onstage/g.php?MTID=e4fc435aebfcdedafed56b82e7def8173

Event number 171 493 2224

Event password 1234

Join by audio only +1-415-655-0003 US TOLL

Monday, Nov. 9, 2020: 6 p.m. to 8 p.m.

https://ncdenrits.webex.com/ncdenrits/onstage/g.php?MTID=ebedeb5306d80ed62d46c9b0db81f9783

Event number 171 937 9432

Event password 1234

Join by audio only +1-415-655-0003 US TOLL

Questions about the estuarine striped bass stocks, fisheries, or Amendment 2 to the North Carolina Estuarine Striped Bass Fishery Management Plan?

Contact the leads:

Charlton Godwin

Fisheries Biologist DMF, Elizabeth City

252-264-3911

Co-lead

Todd Mathes

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Co-lead

Jeremy McCargo

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Questions about the FMP Process?

Kathy Rawls

Fisheries Management Section Chief, Morehead City

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Corrin Flora

Fisheries Management Plan Coordinator, Morehead City

252-726-7021

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Purpose of the Scoping Document

The purpose of this document is to inform the public the review of the N.C. Estuarine Striped Bass Fishery Management Plan (FMP) is underway and to provide an opportunity for the public to comment on identified management strategies or identify other relevant strategies in the management of the estuarine striped bass fishery. Striped bass in North Carolina are jointly-managed by the N.C. Marine Fisheries Commission (MFC) and N.C. Wildlife Resources Commission (WRC). Input received at the start of the FMP review process may shape the final amendment and its management measures (solutions). To help focus the input received from the public, this document provides an overview of initially identified strategies, as well as background information on the fisheries and the stocks. A series of questions about each strategy is also provided for the public to consider when thinking about the strategies; in general: What should estuarine striped bass management be? Are changes needed and, if so, what changes are needed?

Additional management strategies may be considered in Amendment 2 dependent on statutory requirements, available data, research needs, and the degree of impact the management strategy would have and how effective the solution would be. If the division determines a management strategy raised during the scoping period might have positive impacts on the stocks, additional examination of the strategy may be undertaken in the development of the FMP.

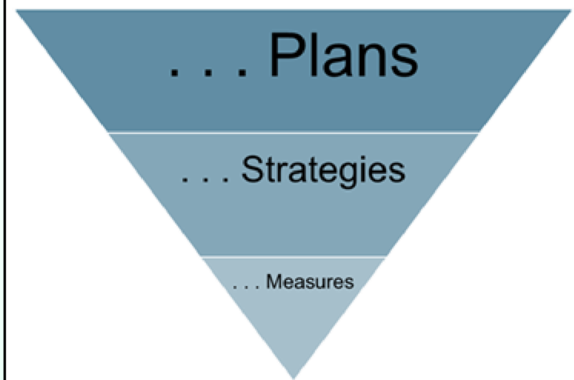
> Scoping provides an opportunity for the public to comment on strategies identified by the division as well as any additional relevant strategies for possible consideration for the development of the FMP.

What is Scoping?

Scoping is the first stage of the process to determine the appropriate contents of an FMP. Scoping serves many purposes including: (1) to provide notice to the public that a formal review of the FMP is underway by the N.C. Division of Marine Fisheries (DMF or division), (2) inform the public of the stock status of the species (3) solicit stakeholder input on a list of strategies identified by the DMF and identify other relevant strategies that may need to be addressed, and (4) recruit potential advisors to serve on the advisory committee (AC) for the FMP that is appointed by the MFC. The public will have more opportunity to provide comments as the amendment is developed; however, scoping is the first and best opportunity to provide input on potential strategies for DMF to consider before an amendment is developed.

FISHERY MANAGEMENT PLANS - A TIERED APPROACH

Fishery Management



Management PLANS are implemented to achieve specified management goals for a fishery, such as sustainable harvest, and include background information, data analyses, fishery habitat and water quality considerations consistent with Coastal Habitat Protection Plans, research recommendations, and management strategies.

Management STRATEGIES are adopted to help reach the goal and objectives of the plan. They are the sum of all the management measures selected to achieve the biological, ecological, economic, and social objectives of the fishery.

Management MEASURES are the actions implemented to help control the fishery as stipulated in the management strategies.

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Developing an amendment

WRC electrofishing spawning stock survey index of abundance Roanoke River, Weldon, NC.

Annually, the DMF reviews all species for which there are FMPs for North Carolina and provides an update to the MFC. This review indudes any recommended changes to the schedule for FMP review and amendment development. Per N.C. law, any changes to the schedule must be approved by the N.C. Department of Environmental Quality (N.C. DEQ) Secretary.

When a plan is opened for review, the first step of the formal amendment process begins with a stock assessment of the species when applicable, followed by the scoping period. After relevant strategies have been identified by the DMF, the public (during the scoping period), and by the MFC, the division's plan development team (PDT) develops a preliminary draft amendment. The first draft will be completed before the FMP AC is appointed. Once appointed, the AC will meet with the PDT at a series of workshops to assist in developing the FMP by further refining the draft amendment. Upon completion of this draft, the amendment is taken to the MFC for approval to go out for public comment and review by the MFC's standing and regional ACs. Following consideration of public and AC comment, the MFC selects its preferred management measures for Amendment 2. Next, draft Amendment 2 goes to the N.C. DEQ Secretary and the legislature for review before the MFC votes on final approval of the amendment.

In the case of a jointly managed species such as striped bass, the WRC consults throughout the FMP amendment process. WRC staff participate in the development of the stock assessment and serve on the PDT. Concurrent with MFC actions, the WRC board reviews the draft FMP, selects preferred management measures, considers its support of the final FMP recommendations, and initiates rulemaking as required.

FMP Timeline

We are here

- Public scoping meetings
- DMF prepares draft Amendment 2
- FMP AC and DMF work together to further develop Amendment 2
- DMF selects initial management recommendations
- MFC votes to send draft FMP for public and AC review
- Public comment and AC meetings for review of draft Amendment 2
- MFC selects preferred management options
- N.C. DEQ Secretary and legislature review draft FMP

Summer 2022

- MFC votes on final adoption of Amendment 2

Why is this happening now?

Pictured: Adam B.
Cape Fear River, N.C.

The 2020 N.C. FMP Review Schedule shows the review of the N.C. Estuarine Striped Bass FMP is underway. To begin the development of Amendment 2 to the N.C. Estuarine Striped Bass FMP, the division conducted assessments of the Albemarle-Roanoke striped bass stock, and the striped bass stocks in the Tar-Pamlico, Neuse, and Cape Fear rivers.

Amendment 2 Background

There are two geographic management units and four striped bass stocks included in the North Carolina Estuarine Striped Bass FMP. The northern management unit is comprised of two harvest management areas: the Albemarle Sound Management Area (ASMA) and the Roanoke River Management Area (RRMA). The striped bass stock in these two harvest management areas is referred to as the Albemarle-Roanoke (A-R) stock, and its spawning grounds are in the Roanoke River in the vicinity of Weldon, NC. The southern geographic management unit is the Central Southern Management Area (CSMA) and includes all internal coastal, joint and contiguous inland waters of North Carolina south of the ASMA to the South Carolina state line. There are spawning stocks in each of the major river systems within the CSMA; the Tar-Pamlico, the Neuse, and the Cape Fear. Only the A-R stock is included in the management unit of Amendment 6 to the Atlantic States Marine Fisheries Commission's (ASMFC) Interstate FMP for Atlantic Striped Bass (ASMFC 2003).

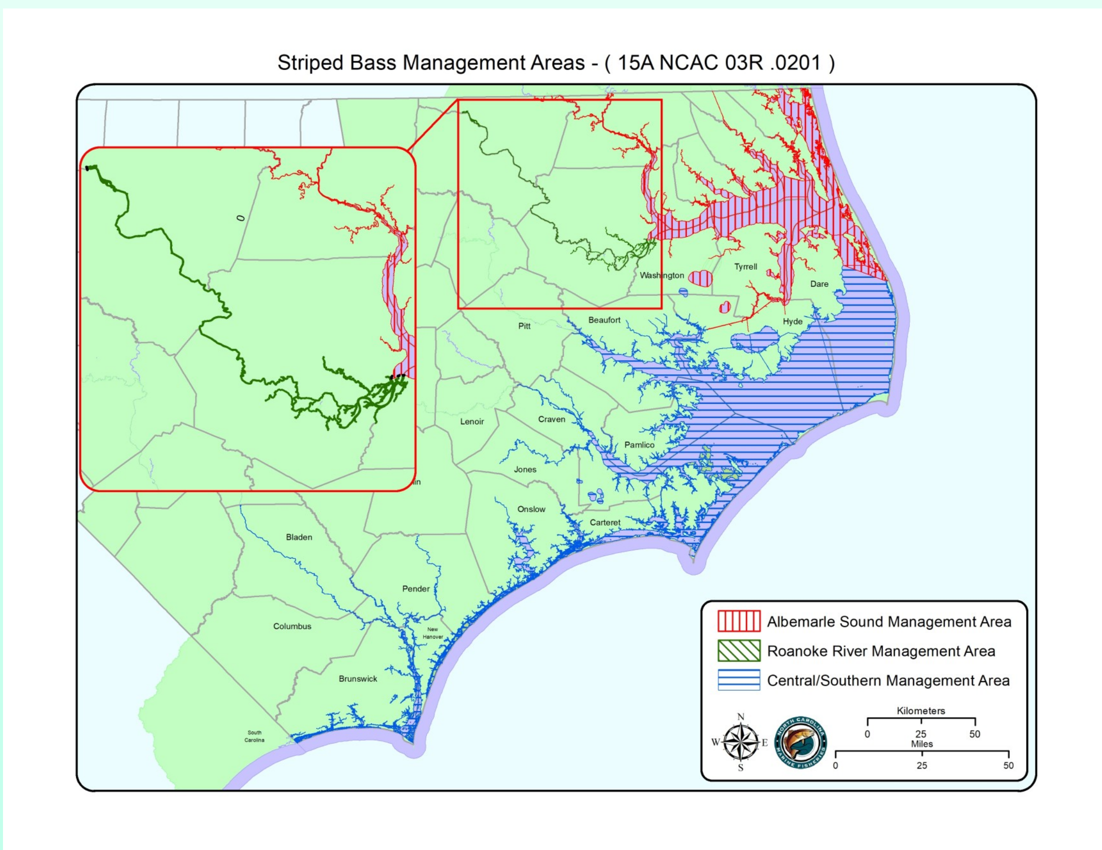

Figure 1. North Carolina's estuarine striped bass management areas.

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Albemarle-Roanoke striped bass stock assessment and stock status

Results from the 2020 benchmark stock assessment indicate the A-R striped bass stock is overfished and overfishing is occurring in the terminal year of the assessment (2017) relative to the updated biological reference points (BRPs). These BRPs are based on spawning stock biomass (SSB) targets and thresholds of $SSB_{45\%SPR\ Target}$ = 350,371 lb and $SSB_{35\%SPR\ Threshold}$ = 267,390 lb respectively, and fishing mortality (F) targets and thresholds of $F_{45\%SPR\ Target}$ = 0.13 and $F_{35\%SPR\ Threshold}$ = 0.18 (Figures 2 and 3; Lee et al. 2020).

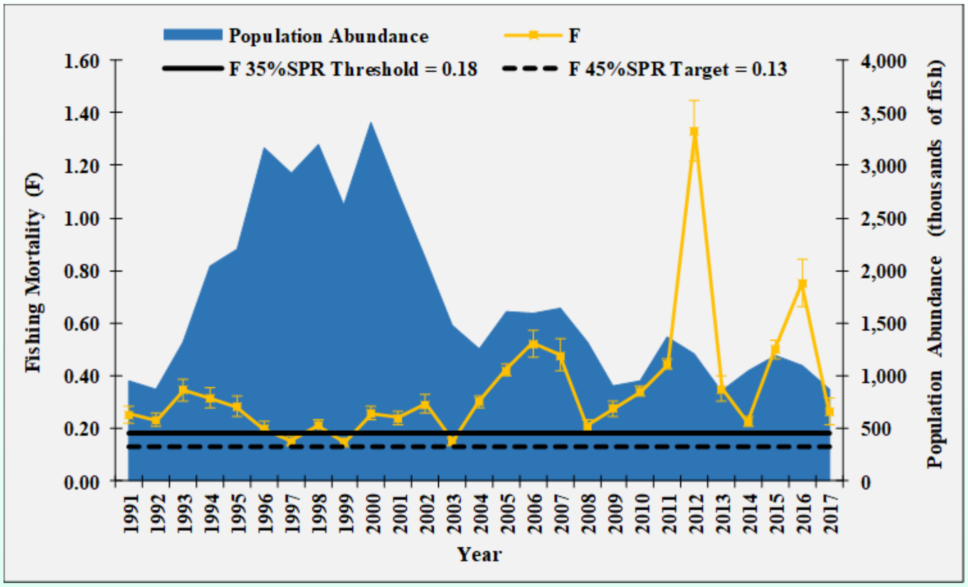

Figure 2. Estimates of fishing mortality (F) and population abundance for the Albemarle-Roanoke striped bass stock, 1991–2017. Source: Lee et al. 2020.

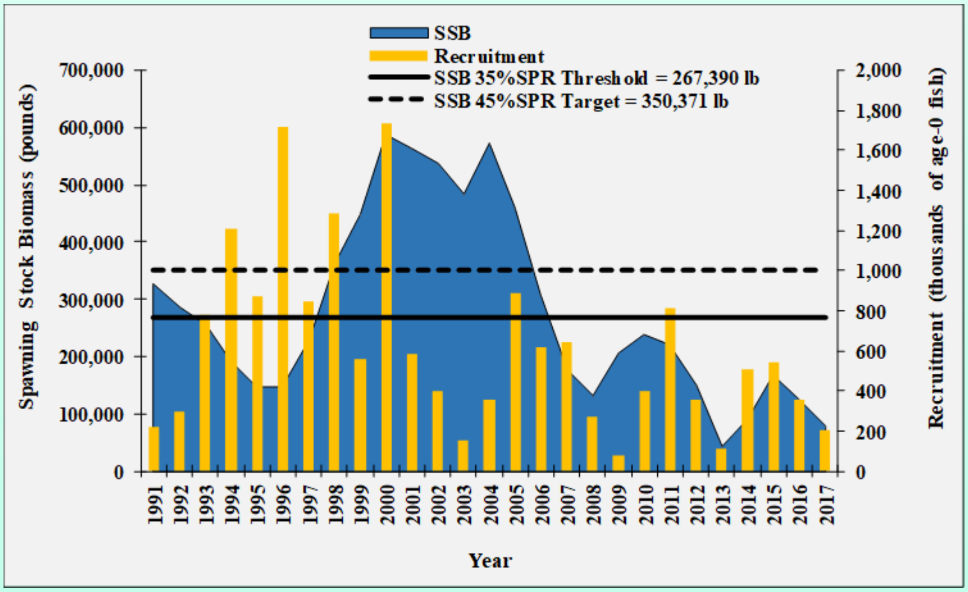

Figure 3. Estimates of spawning stock biomass (SSB) and recruitment of age-0 fish coming into the population each year for the Albemarle-Roanoke striped bass stock, 1991–2017. Source: Lee et al. 2020.

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Albemarle-Roanoke Striped Bass in North Carolina

A-R striped bass have long supported recreational and commercial fisheries in the Albemarle Sound region and its tributaries and the northern Outer Banks. Commercial harvest of striped bass occurs throughout the fall and winter into the early spring. Since 1991 gill-nets are the main commercial harvest gear with minimal harvest also from pound nets. Recreational striped bass fishing occurs throughout the year, with harvest seasons allowed in the fall and winter and through the spring as striped bass migrate to the spawning grounds. During the late spring and summer, catch-and-release fishing is also popular.

Recreational anglers, Albemarle Sound bridge. Photo credit: DMF staff
Pictured: K.D. and Kenny Hewitt

Harvest has been controlled by a fixed annual poundage amount known as total allowable landings (TAL) since 1991. The TAL is split evenly between commercial and recreational sectors, and the recreational TAL is further divided evenly between the ASMA and RRMA (Figure 4). Since the last TAL increase to 550,000 lb in 2003, combined landings from all fisheries in the ASMA and RRMA have not exceeded 460,853 lb and have averaged 235,278 lb per year with a low of 108,432 lb in 2013. The commercial sector did not reach their TAL in any years from 2005 to 2013. Even with the 2014 reduction in the TAL to 275,000 lb the commercial and recreational sectors in the ASMA did not reach the TAL for years 2014–2017. Harvest in all sectors has increased since 2017, with the commercial sector reaching the TAL in 2019 causing the DMF to close the fall commercial harvest season before December 31 for the first time since 2010. This increase in harvest is likely due to the above-average year classes produced in 2014 and 2015 (Figures 3 and 4).

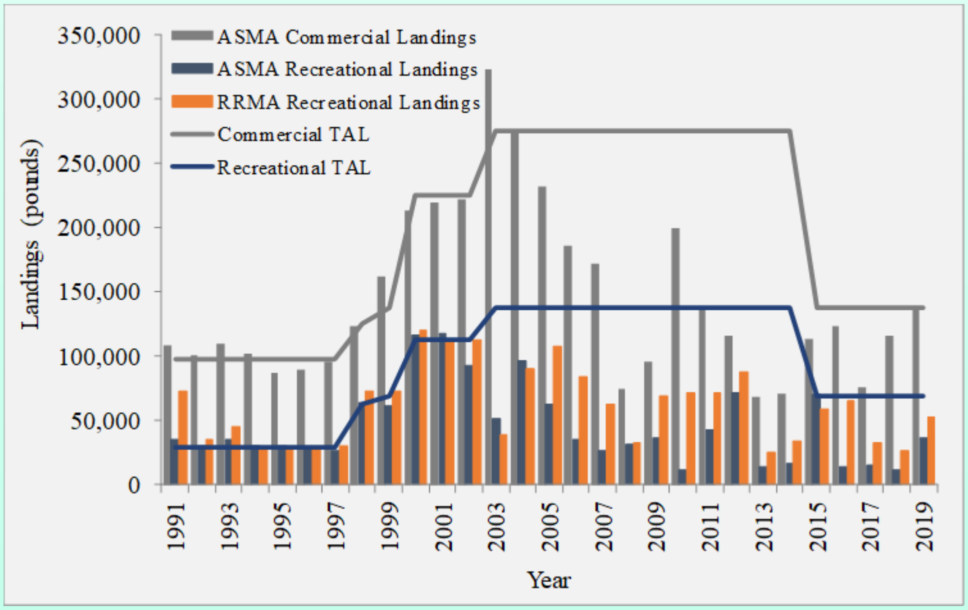

Figure 4. Striped bass landings from the Albemarle Sound Management Area commercial and recreational sectors and Roanoke River Management Area recreational sector, and the commercial and recreational total allowable landings, 1991–2019.

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Pictured: Kaden

Based on results from the estimates of total abundance from the stock assessment (Figure 2), the reason for the decline in harvest is likely a decline in overall stock abundance due to poor recruitment starting in 2001 (Figure 3). The assessment noted the importance of river flow on recruitment and noted declining recruitment in the time series does not appear to result solely from reduced abundance due to amount harvested, as recruitment started declining when SSB was at high levels (Figure 3; Lee et. al 2020).

Average total removals in the fisheries (sector combined) during 2012–2017 were composed of 84% landings, with dead discards equaling 16% in numbers of fish (Figure 5). Discards in the ASMA commercial fishery from 2012 to 2017 were estimated using a generalized linear model framework based on on-board observer data combined with data from the DMF Trip Ticket Program. Discards in the recreational fishery are estimated by multiplying the number of fish released by a delayed mortality estimate of 6.4% (Nelson 1998).

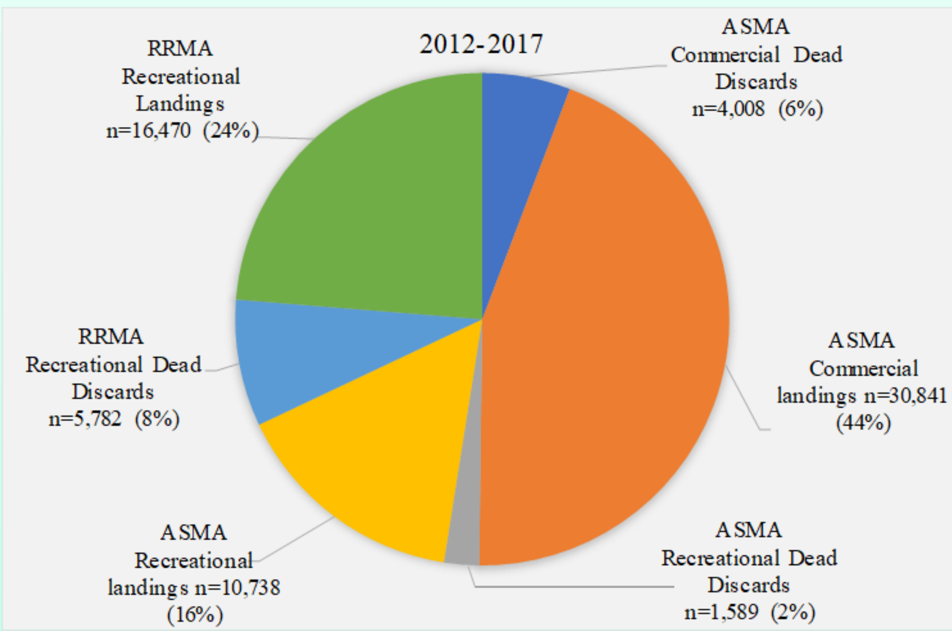

Figure 5. Average number of striped bass landed and discarded from the commercial and recreational fisheries in the Albemarle Sound Management Area (ASMA) and Roanoke River Management Area (RRMA), 2012-2017. Source: Lee et al. 2020.

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Tar-Pamlico, Neuse, and Cape Fear river striped bass stocks review

There is no stock status determination for the CSMA striped bass stocks, comprised of the Tar-Pamlico, Neuse, and Cape Fear rivers. Continuous stocking efforts since 1980 and lack of natural recruitment in these waters prevent the use of traditional stock assessment techniques. The Central Southern Management Area Stock Report (Mathes et al. 2020) is a documentation of all data collected, management efforts, and major analyses completed for these river stocks.

Juvenile striped bass tagged for stocking into the Tar-Pamlico River
Photo By: Corrin Flora

Striped Bass Larvae
Photo By: Robert Michelson, Coastal Review Online

The report also serves as a record of completed research efforts with implications for fishery management and as a guide for future research based on results and identified data gaps. It evaluates the likelihood of successful population rebuilding under various simulations of stocking and fishery management strategies such as different harvest levels and size limits. Tagging studies in the Cape Fear River showed a consistent decline in striped bass abundance estimates from 2012 to 2018 despite a no-possession regulation since 2008. The need for continued conservation to achieve a sustainable harvest is supported by the lack of recruitment, constrained size and age distributions, low abundance, the absence of older fish in all stocks, and the high percentage of stocked fish in the population (Cushman et al. 2018; Farrae and Darden 2018).

Tar-Pamlico, Neuse, and Cape Fear river striped bass in North Carolina

Striped bass have long supported recreational and commercial fisheries in the CSMA region and its tributaries. Since 2004 commercial landings in the CSMA have only been allowed in the spring of the year and have been constrained by an annual TAL of 25,000 pounds established in 1994. Over the past 10 years, landings have closely followed the annual TAL due to daily quota monitoring that allows the season to be closed each year when the TAL is reached, except for 2008 when less than half of the TAL was landed and the season stayed open through April 30. Since 2004 striped bass commercial landings in the CSMA have averaged 24,179 pounds and ranged from a low of 10,115 pounds in 2008 to a high of 32,479 pounds in 2004 (Figure 6).

Within the CSMA recreational harvest occurs in the fall and spring and there is a significant recreational catch-and-release fishery throughout the year. Since 2004 striped bass recreational landings have averaged 13,511 pounds but in 2016 and 2017 recreational harvest increased to just over 25,000 lb each year (Figure 6).

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From 2012 to 2017 total removals in the commercial and recreational fisheries were composed of 73% landings and 27% dead discards (Figure 7). Discards in the CSMA commercial fishery from 2012 to 2017 were estimated using a generalized linear model framework using on-board observer data combined with data from the DMF trip ticket program. Discards in the recreational fishery are estimated by multiplying the number of fish released by a delayed mortality estimate of 6.4% (Nelson 1998).

Pictured: DMF Staff. Roanoke River, Weldon, NC

There has been a commercial and recreational no-possession provision in the Cape Fear River since 2008. At the MFC's February 2019 business meeting, Supplement A to Amendment 1 to the North Carolina Estuarine Striped Bass FMP was approved instituting a recreational and commercial no-possession provision in the CSMA. On March 13, 2019, the MFC held an emergency meeting at which time they passed a motion requiring the Director to issue a proclamation prohibiting the use of all gill-nets upstream of the ferry lines from the Bayview Ferry to Aurora Ferry on the Pamlico River and the Minnesott Beach Ferry to Cherry Branch Ferry on the Neuse River.

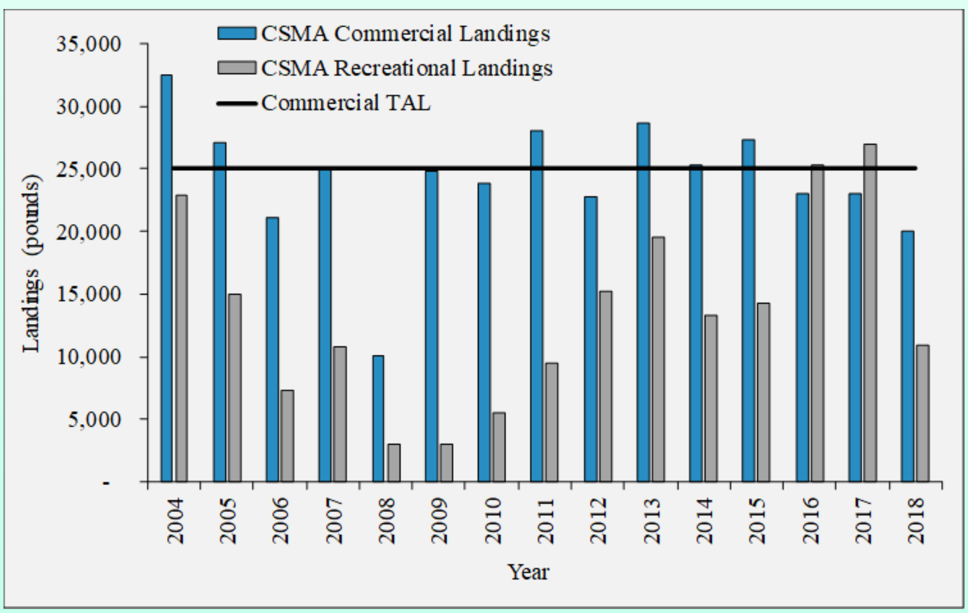

Figure 6. Striped bass landings from the Central Southern Management Area (CSMA) commercial and recreational sectors and the commercial total allowable landings (TAL), 2004–2018. Commercial landings were included for the Cape Fear River for 2004–2008. Recreational landings include the Tar-Pamlico and Neuse rivers only.

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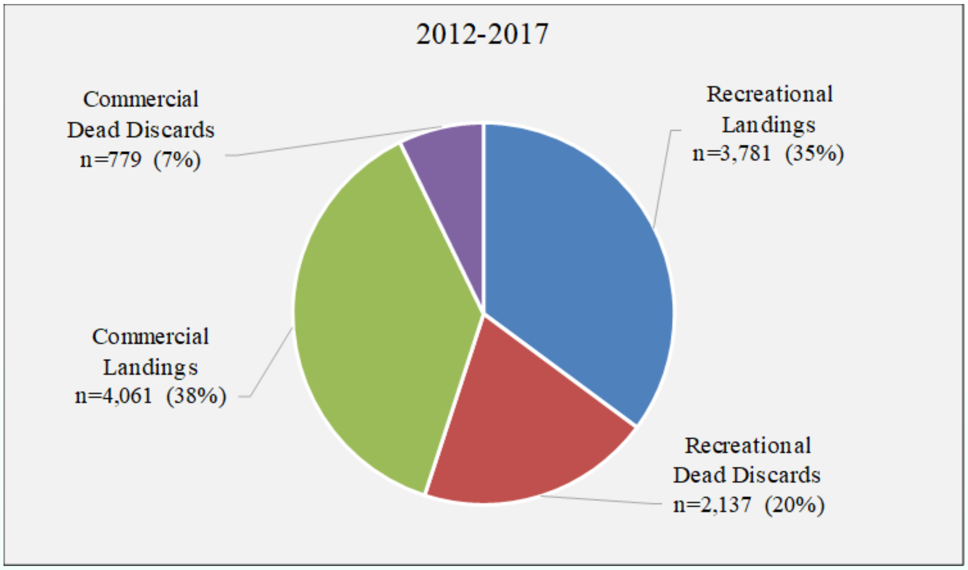

Figure 7. Average number of striped bass landed and discarded from the commercial and recreational fisheries in the Tar-Pamlico and Neuse rivers, 2012–2017.

Habitat and Fish Stocks

With the important relationship between habitat and fish populations, the goal to protect and enhance habitats supporting coastal fisheries comes from the implementation of the Coastal Habitat Protection Plans (NCDEQ. 2016; CHPP, G.S. 143B-279.8). While much of the concern over declining fish stocks has been directed at overfishing, habitat loss and water quality degradation make a stock more susceptible to decline and may hinder stock recovery efforts. The CHPP is undergoing its mandated five-year review, with adoption planned for summer 2021. One of the priority issues, "Submerged Aquatic Vegetation (SAV) Protection and Restoration, with Focus on Water Quality Improvements" has implications for North Carolina striped bass stocks. SAV is especially sensitive to water quality impairment from nutrient and sediment pollution and has been considered a "coastal canary", serving as a valuable bio-indicator of the overall health of coastal ecosystems (Stevenson, 1998). The primary mechanism to restore and sustain SAV is by improving water quality. The CHPP strategy for SAV involves modifying water quality criteria, such as chlorophyll a levels and nutrient standards to reduce nutrient loading, allowing increased light penetration that is critical for submerged vegetation. This will not only benefit SAV but address the algal blooms in the Albemarle Sound area and other poor water quality impacts to fish like striped bass. It is imperative the fishing community actively participate in the ongoing CHPP review and add their voice to support the actions outlined in the CHPP.

Algae Bloom, Chowan River, Bertie County. Photo By: DMF Staff

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Amendment 2 Management Strategies

Albemarle-Roanoke Striped Bass Stock
Sustainable Harvest:

Background

Although this document is specific to the ongoing development of Amendment 2 to the N.C. Estuarine Striped Bass FMP, it is important to note under the existing Amendment 1 there is adaptive management language that states, “Should the target F be exceeded, then restrictive measures will be imposed to reduce F to the target level” (NCDMF 2013). Actions authorized in Amendment 1 are being considered to lower F to address sustainable harvest in the interim as Amendment 2 is completed. This action maintains compliance with Amendment 1 to the North Carolina Estuarine Striped Bass FMP and ASMFC’s Addendum IV to Amendment 6 to the Interstate FMP for Atlantic Striped Bass while the Amendment 2 sustainable harvest management strategy is developed.

Amendment 2 will focus on development of management strategies that address both the overfished and overfishing status of the A-R stock relative to the Fisheries Reform Act (FRA) of 1997, which states each plan “shall specify a time period, not to exceed two years from the date of the adoption of the plan, for ending overfishing…” and “specify a time period, not to exceed 10 years from the date of adoption of the plan, for achieving a sustainable harvest”. Projections from the terminal year of the stock assessment that model how SSB responds in the coming years to various levels of harvest are used to calculate a new TAL that will accomplish the dual mandate of the FRA. As shown in Figure 8, the actual level of recruitment occurring in future years is an important factor in the level of expected increase in SSB. Projections use multiple levels of recruitment to inform managers of the uncertainty associated with assumptions about future stock recruitment and the related increases in SSB.

Pictured: Jennifer Lewis

Tagging on the spawning grounds
Roanoke River, Weldon NC. DMF staff

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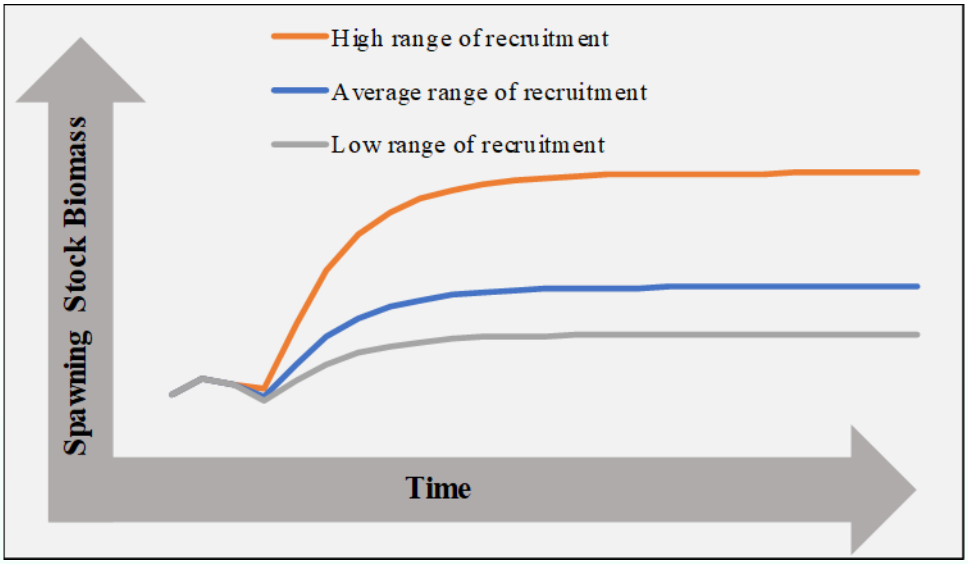

Figure 8. A graphical illustration of how assumptions about the level of future recruitment impacts stock projections of spawning stock biomass (SSB).

The necessary management measures currently in place in Amendment 1 to manage a TAL and prevent harvest from exceeding it each year include:

- adjust the TAL based on benchmark stock assessments and assessment updates
- daily quota monitoring of commercial harvest
- weekly quota monitoring of recreational harvest
- open and/or close harvest seasons to remain below the TAL
- authorize or restrict fishing methods and gear
- limit size, quantitates taken or possessed (i.e., daily recreational creel limits and commercial limits)
- restrict fishing areas

Striped bass being tagged with commercial harvest tags
Frog Island fish house Weeksville, NC
Photo By: Chris Kelly

Pictured: Shane

Questions for the Public

- Which of the existing management measures do you support to maintain harvest within limits of the specified TAL?
- In the event of a low TAL that restricts the regular harvest seasons, would you prefer a short season of consecutive harvest days or slightly longer season with only selected harvest days each week? Which harvest days would you prefer?
- Do you support investigating size limit changes for A-R striped bass?
- What recreational and/or commercial gear or area restrictions would you support to reduce discard mortality to rebuild the A-R stock?

Tar-Pamlico, Neuse, and Cape Fear rivers striped bass stocks:

Sustainable Harvest:

Background

There has been a commercial and recreational no-possession provision in the Cape Fear River and its tributaries since 2008. This no-possession measure was implemented to help support specific goals of Amendment 1, which are to achieve sustainable harvest through science-based decision-making processes that conserves the resource. Prior to 2019, harvest in the CSMA was managed by commercial and recreational seasons, harvest and size limits, and gear restrictions, and constrained by an annual commercial TAL of 25,000 lb. Additionally, measures in Supplement A to Amendment 1 of the N.C. Estuarine Striped Bass FMP were implemented in March 2019 that implemented a no-possession provision in the commercial and recreational striped bass fisheries, as well as commercial set gill-net restrictions requiring tie-downs and distance from shore (DFS) measures to apply year-round, in the CSMA (NCDMF 2019). Supplement actions need to be contained within Amendment 2 management strategies in order to stay in effect.

Concurrent in timing but independent of the MFC's adoption of Supplement A is the MFC directed proclamation that prohibits the use of all gill-nets upstream of the ferry lines from the Bayview Ferry to Aurora Ferry on the Pamlico River and the Minnesott Beach Ferry to Cherry Branch Ferry on the Neuse River. As in this case when the commission enacted the provision to direct issuance of a proclamation, the fisheries director has no discretion to choose another management option and is bound by law to follow the commission decision. The MFC may alter this directive at any time or as part of Amendment 2, and if they choose not to do so, the proclamation actions remain in effect.

Harvest will be allowed if the no-possession measure in Supplement A is not continued in Amendment 2, and other management strategies should be considered to rebuild the stock. Possible stocking and fishery management strategies for CSMA striped bass were evaluated using a demographic matrix model (Mathes et al. 2020). Model results indicated CSMA striped bass populations are depressed to an extent that sustainability is unlikely at any level of fishing mortality. Lack of natural reproduction in CSMA systems requires continuous stocking to maintain the populations unless environmental and biological characteristics are improved.

NCSU graduate student surgically implanting a acoustic tracking tag in a striped bass to be stocked in the Neuse river. Photo By: USFWS.

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Management strategies could be implemented to expand the age structure of the population and increase abundance of older fish which, given appropriate environmental conditions, may promote natural reproduction. Some environmental conditions can be addressed through the CHPP while biological characteristics can be addressed by altering stocking strategies including consideration of stocking fish better suited to environmental conditions in the CSMA. However, if management strategies implemented through Amendment 2 are unsuccessful at achieving sustainable harvest and external factors are deemed to make establishment of sustainable striped bass populations in CSMA systems impossible, other management strategies, including returning to a hatchery-supported fishery, could be considered in future Amendments.

If the no-harvest provision in the CSMA remains in place, adaptive management could be used to determine under what conditions the fishery could re-open. For example, collecting young-of-year striped bass in juvenile sampling would indicate successful natural reproduction, decreased contribution of stocked fish could potentially indicate successful recruitment, an increase in the number of older fish would indicate expansion of the age structure of the stock, and increased abundance in the independent surveys could indicate population growth. Conversely, adaptive management could also be used as a means to reconsider management strategies if establishment of self-sustaining populations in CSMA systems is determined to be unattainable.

DMF staff conducting Independent
Gill Net Index of Abundance Survey
Western Albemarle Sound

Questions for the Public

No-Possession Provision – Amendment 1 (applicable to Cape Fear River) and Supplement A Management Measures

If the No-Possession Provision is Continued

- Do you support continuing the no-possession provision in the CSMA? For how long?
- If the no-possession provision remains, what gear modifications or restrictions should be considered to reduce bycatch and discards?
- Do you support continued stocking in the CSMA?

If the No-Possession Provision is Not Continued

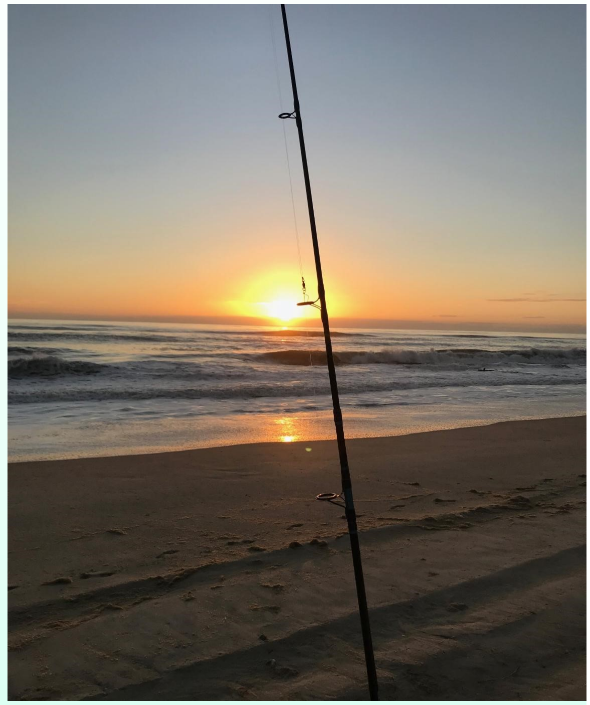
- What management measures should be considered to allow for sustainable harvest (i.e., TAL, closed and open harvest seasons, daily trip limits)?
- Do you support investigating size limit changes for CSMA striped bass?
- What gear modifications or restrictions should be considered to reduce bycatch and discards?
- Do you support continued stocking in the CSMA?

Applicable to all North Carolina's Striped Bass stocks:

Hook-and-line allowed as legal commercial gear in North Carolina's striped bass fisheries:

Background

Amendment 1 to the N.C. Estuarine Striped Bass FMP included an issue paper discussing hook-and-line as a legal commercial gear in the ASMA and CSMA commercial striped bass fisheries. The result was a recommendation by the DMF and MFC to maintain status quo with adaptive management – (Do not allow hook-and-line as commercial gear in the estuarine striped bass fishery unless the use of traditional gears is prohibited). However, through development of the Amendment 1 and discussing the issue paper, the ACs and the DMF recognized that while allowing hook-and-line as a commercial gear could potentially have some positive impacts to the striped bass resource and stakeholders, there would need to be additional discussion of how to best implement the measure. Therefore, the rule that specifically prohibited the use of hook-and-line as a commercial gear was repealed and now that gear is prohibited as a commercial gear in the striped bass fishery through proclamation. If through development of Amendment 2 the MFC votes to allow hook-and-line as a commercial gear, the tools are already in place to implement the measure.



Recreational angling, Outer Banks N.C.
Photo By: Rick Denton

Questions for the Public

- Do you support hook-and-line as a legal commercial gear in the striped bass commercial fishery?

Photo By: Mitchell Blake

Pictured: DMF Staff

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Pictured: Adam B. Cape Fear River, N.C.

Questions for the Public about Potential Management Strategies

1. What management strategies already under consideration do you support for Amendment 2?

2. Are there other relevant strategies not included herein that should be consider for Amendment 2?

Additional management strategies may be considered in Amendment 2 dependent on statutory requirements, available data, research needs, and the degree of impact the management strategy would have and how effective the solution would be. If the division determines a management strategy raised during the scoping period might have positive impacts on the stocks, additional examination of the strategy may be undertaken in the development of the FMP Amendment 2.

Photo By: Adam B. Cape Fear River, N.C.

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Literature Cited


Photo By: K. D. Hewitt

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Cushman, B., T. O'Donnell, and D. Farrae. 2018. South Carolina Department of Natural Resources. 2017 Striped Bass Genotyping and Parentage Analysis Final Report for the North Carolina Wildlife Resources Commission. 39 pp.

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Lee, L.M., T.D. Teears, Y. Li, S. Darsee, and C. Godwin (editors). 2020. Assessment of the Albemarle Sound -Roanoke River striped bass (Morone saxatilis) in North Carolina, 1991–2017. North Carolina Division of Marine Fisheries, NCDMF SAP-SAR-2020-01, Morehead City, North Carolina. 171 p.

Mathes, T., Y. Li, T. Teears, and L.M. Lee (editors). 2020. Central Southern Management Area striped bass stocks in North Carolina, 2020. North Carolina Division of Marine Fisheries, NCDMF SAP-SAR-2020-02, Morehead City, North Carolina. 161 p. + appendices.

Nelson, K.L. 1998. Catch-and-release mortality of striped bass in the Roanoke River, North Carolina. North American Journal of Fisheries Management 18:25–30.


Wild young-of-year striped bass, DMF juvenile striped bass index of abundance survey

NCDMF. 2013. Amendment 1 to the North Carolina estuarine striped bass fishery management plan. North Carolina Department of Environment and Natural Resources. North Carolina Division of Marine Fisheries. Morehead City, NC. 826 pp.

NCDMF. 2019. Supplement A to Amendment 1 to the North Carolina estuarine striped bass fishery management plan. North Carolina Department of Environment and Natural Resources, North Carolina Division of Marine Fisheries, Morehead City, North Carolina. 40 p.

Stevenson, J. C. 1988. Comparative Ecology of Submersed Grass Beds in Freshwater, Estuarine and Marine Environments. Limnology and Oceanography 33: 867–893.

Recreational anglers, Roanoke River, Weldon, N.C.

Scoping Document

Management Strategies for Amendment 2 to the N. C. Estuarine Striped Bass Fishery Management Plan

NORTH CAROLINA DIVISION OF MARINE FISHERIES

DMF Headquarters
3441 Arendell Street
PO Box 769
Morehead City, NC 28557

800-682-2632
252-726-7021
http://portal.ncdenr.org/web/mf/home

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RULEMAKING UPDATE

ROY COOPER
Governor

MICHAEL S. REGAN
Secretary

STEPHEN W. MURPHEY
Director

Oct. 23, 2020

MEMORANDUM

TO: N.C. Marine Fisheries Commission

FROM: Catherine Blum, Rulemaking Coordinator
Marine Fisheries Commission Office

SUBJECT: Rulemaking Update

Issue

Update the N.C. Marine Fisheries Commission (MFC) on the status of the 2020-2021 annual rulemaking cycle, including rulemaking in support of the Periodic Review and Expiration of Existing Rules per G.S. 150B-21.3A, and request the MFC vote on final approval of readoption of the Recreational Water Quality Program rules in "Package A".

Findings

- Periodic Review and Readoption of Rules – Requirements
  - North Carolina G.S. 150B-21.3A, adopted in 2013, requires state agencies to review existing rules every 10 years in accordance with a prescribed process that includes rule readoption.
    - 15A NCAC 18A – Sanitation: On Jan. 16, 2020, the Rules Review Commission (RRC) approved the readoption schedule of June 30, 2024 for 164 MFC rules.
    - 15A NCAC 03 – Marine Fisheries: On June 14, 2018, the RRC approved the readoption schedule of June 30, 2022 for 172 MFC rules.
  - The MFC must readopt these rules by these deadlines or the rules will expire and be removed from the N.C. Administrative Code.
- The MFC is scheduled to receive an update on public comments received about and vote on final approval of readoption of the seven Recreational Water Quality Program rules in 15A NCAC 18A .3401-.3407, Coastal Recreational Waters Monitoring, Evaluation, and Notification. If approved, the rules have an intended effective date of April 1, 2021, which coincides with the start of the 2021 recreational swimming season.

Action Needed

The MFC is scheduled to vote on final approval of readoption of the Recreational Water Quality Program rules.

Recommendation

The division recommends the MFC vote on final approval of readoption of the Recreational Water Quality Program rules. For more information, please refer to the Rulemaking section of the briefing materials.

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2020-2021 Annual Rulemaking Cycle

"Package A" (7 rules)

Coastal Recreational Waters Monitoring, Evaluation, and Notification

At its May 2020 business meeting, the MFC approved Notice of Text for readoption of the seven rules in 15A NCAC 18A .3401-.3407, Coastal Recreational Waters Monitoring, Evaluation, and Notification. These rules were adopted in 2004 and need updating to bring the Recreational Water Quality Program into compliance with new Environmental Protection Agency criteria and standards released in 2014 and to be more efficient as a program in protecting public health. The purpose of the program is to protect public health by monitoring recreational coastal waters and to notify the public when samples collected exceed the safe swimming standard. The new guidance is recommending the same bacterial threshold for all swimming locations regardless of usage category. These bacteriological limits will create efficiencies for how the division issues public notifications when samples collected exceed the safe swimming standard.

On Aug. 3, 2020 the proposed rules were published in the *N.C. Register*. The rules have an intended effective date of April 1, 2021, coinciding with the start of the 2021 recreational swimming season and creating a smooth transition. The MFC accepted public comments on the proposed rules from Aug. 3 through Oct. 2, 2020; one public comment was received in support of the rules. An online public hearing was also held via WebEx on Aug. 26, 2020. There were five members of the public in attendance; however, no public comments were received. The MFC is scheduled to receive an update on the public comments at its November 2020 business meeting and vote on final approval of the rules.

For more information, please refer to the materials for "Package A" in the Rulemaking section of the briefing materials, including a table showing the timing of the steps in the process, the Aug. 3, 2020 news release announcing the public comment opportunities for the proposed rules, an excerpt from the Aug. 3, 2020 *N.C. Register* when the proposed rules were published, a summary of the public hearing, and the written comment received.

"Package B" (50 rules)

Update on Periodic Review and Expiration of Existing Rules

At its August 2020 business meeting, the MFC approved Notice of Text for readoption and amendment of the 50 rules in "Package B". These rules cover the following subjects:

- Classification of Shellfish Growing Waters and Laboratory Procedures (14 rules)
- Rules with minor changes relating to standards for commercial shellfish sanitation and processing procedures (21 rules)
- Shellfish Lease User Conflicts, per Session Law 2019-37 (3 rules)
- General Regulations: Joint (9 rules)
- Shrimp Fishery Management Plan Amendment 1 Special Secondary Nursery Areas (2 rules; 1 readoption and 1 amendment)
- Oyster Sanctuaries (1 rule amendment)

On Oct. 1, 2020 the proposed rules were published in the *N.C. Register*. The MFC is accepting public comments from Oct. 1 through 5 p.m. Nov. 30, 2020. Public comments on the proposed rules may be submitted by an online form available at http://portal.ncdenr.org/web/mf/mfc-proposed-rules (click on

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April 1, 2021 Package B) or by U.S. mail to division Rules Coordinator Catherine Blum, P.O. Box 769, Morehead City, NC 28557. Comments submitted by email will not be accepted. Online public hearings were also scheduled for Oct. 21 and 27, 2020 at 6 p.m. via WebEx. The proposed rules and the corresponding fiscal analyses are available on the website as well.

The MFC will receive an update on the public comments at its February 2021 business meeting and will be requested to vote on final approval of the rules. Please refer to the materials for “Package B” in the Rulemaking section of the briefing materials, including a table showing the timing of the steps in the process, the news release announcing the public comment opportunities for the proposed rules, and an excerpt from the Oct. 1, 2020 *N.C. Register* when the proposed rules were published.

2021-2022 Annual Rulemaking Cycle Preview

Division staff will provide a preview of potential rules in the MFC’s 2021-2022 annual rulemaking cycle at its November 2020 business meeting. There will be two packages of rules, similar to the 2020-2021 cycle, due to the number of rules remaining to be readopted. Please see Figure 1, detailed in the Background Information section below, that shows the MFC’s rule readoption schedule. Also, the Rulemaking section of the briefing materials includes tables showing the timing of the steps in the process for “Package A” and “Package B” of the 2021-2022 cycle.

Background Information

Periodic Review and Expiration of Existing Rules per G.S. 150B-21.3A

Session Law 2013-413, the Regulatory Reform Act of 2013, implemented requirements known as the “Periodic Review and Expiration of Existing Rules.” These requirements are codified in a new section of Article 2A of Chapter 150B of the General Statutes in G.S. 150B-21.3A. Under the requirements, each agency is responsible for conducting a review of all its rules at least once every 10 years in accordance with a prescribed process.

The review has two parts. The first is a report phase, which has concluded, followed by the readoption of rules. An evaluation of the rules under the authority of the MFC was undertaken in two lots (see Figure 1.) The MFC has 211 rules in Chapter 03 (Marine Fisheries), of which 172 are subject to readoption, and 164 rules in Chapter 18, Subchapter 18A (Sanitation) that are also subject to readoption. The MFC is the body with the authority for the approval steps prescribed in the process.

Rules	2017	2018	2019	2020	2021	2022	2023	2024
Chapter 03 (172 rules)	Report	41 Rules Readopted	2 Rules Readopted	13 Rules Proposed	Rule Readoption (116)	6/30/22 deadline		
Subchapter 18A (164 rules)			Report	42 Rules Proposed	Rule Readoption (122)			6/30/24 deadline

Figure 1. Marine Fisheries Commission rule readoption schedule to comply with G.S. 150B-21.3A, Periodic Review and Expiration of Existing Rules.

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RULEMAKING UPDATE

PACKAGE A

2020-2021 ANNUAL RULEMAKING CYCLE TABLE

AUGUST 3 NEWS RELEASE

NC REGISTER PUBLICATION OF PROPOSED RULES

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N.C. Marine Fisheries Commission
2020-2021 Annual Rulemaking Cycle
Package A

November 2020

Time of Year	Action
February-April 2020	Fiscal analysis of rules prepared by DMF staff and approved by Office of State Budget and Management
May 2020	MFC approves Notice of Text for Rulemaking
August 2020	Publication of proposed rules in the *North Carolina Register*
August-October 2020	Public comment period held
Aug. 26, 2020	Public hearing held via WebEx
November 2020	MFC considers approval of permanent rules
January 2021	Rules reviewed by Office of Administrative Hearings/ Rules Review Commission
April 1, 2021	Proposed effective date of rules
April 1, 2021	Rulebook supplement available online
April 15, 2021	Commercial license sales begin

Roy Cooper
Governor

Michael S. Regan
Secretary

Steve Murphey
Director

Release: Immediate	Contact: Patricia Smith
Date: Aug. 3, 2020	Phone: 252-726-7021

MEDIA ADVISORY: Public hearing scheduled for comment on coastal recreational water quality rules

MOREHEAD CITY – The N.C. Marine Fisheries Commission is accepting public comment on proposed amendments and re-adoption of seven rules under a state-mandated periodic review schedule. The rules pertain to coastal recreational water quality monitoring to protect the public health of swimmers.

A public hearing will be held by web conference on Aug. 26 at 6 p.m. The public may join the meeting online; however, those who wish to speak during the hearing must register by noon Aug. 26.

Members of the public also may submit written comments through an online form or through the mail to N.C. Marine Fisheries Commission Recreational Water Quality Rules Comments, P.O Box 769, Morehead City, N.C. 28557. Comments must be posted online or be received by the Division of Marine Fisheries by 5 p.m. Oct. 2, 2020.

Links to the public hearing registration form and online comment form, as well as text of the proposed rules and links to join the meeting, can be found on the N.C. Marine Fisheries Commission's Proposed Rules Page.

Up for re-adoption are marine fisheries rules in 15A NCAC 18A .3400. Rules .3401, .3402, .3403, and .3405 contain the primary proposed changes that will:

- Update biological standards so they align with new federal performance criteria.
- Ensure equal protection for swimmers by requiring the same bacteriological threshold triggers public health advisories for all swimming locations, regardless of usage frequency.
- Modify the public notification process to reduce delays and confusion, without generating an increased frequency of swimming advisories for the public.

Other proposed changes are technical in nature; two rules are proposed for repeal because they duplicate requirements.

The proposed rule changes will be presented to the Marine Fisheries Commission for final approval in November 2020 and have an intended effective date of April 1, 2021.

For questions about the Marine Fisheries Commission rulemaking process, email Catherine Blum, rules coordinator for the N.C. Division of Marine Fisheries. For questions about the proposed changes to the N.C. Recreational Water Quality Program rules, email Erin Bryan-Millush, with the division's Recreational Water Quality Program, or call her at 252-808-8153.

Event Title:	Marine Fisheries Commission Public Hearing for Proposed Rules
Date and Time:	Aug. 26, 2020 at 6 p.m.
WebEx Link:	https://ncdenrits.webex.com/ncdenrits/onstage/g.php?MTID=ea8608d0638d06136715b7a10b3dce68a
Password:	1234
Event Number:	161 720 5186

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Website: http://www.ncdenr.gov
Facebook: http://www.facebook.com/ncdeq
Twitter: http://twitter.com/NCDEQ
RSS Feed: http://portal.ncdenr.org/web/opa/news-releases-rss
1601 Mail Service Center, Raleigh, NC 27699-1601

NORTH CAROLINA
REGISTER

VOLUME 35 ● ISSUE 03 ● Pages 154 – 312

August 3, 2020

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Contact List for Rulemaking Questions or Concerns

For questions or concerns regarding the Administrative Procedure Act or any of its components, consult with the agencies below. The bolded headings are typical issues which the given agency can address but are not inclusive.

Rule Notices, Filings, Register, Deadlines, Copies of Proposed Rules, etc.

Office of Administrative Hearings
Rules Division
1711 New Hope Church Road — 984-236-1850
Raleigh, North Carolina 27609 — 984-236-1947 FAX

contact: Molly Masich, Codifier of Rules	molly.masich@oah.nc.gov	984-236-1934
Dana McGhee, Publications Coordinator	dana.mcghee@oah.nc.gov	984-236-1937
Lindsay Silvester, Editorial Assistant	lindsay.silvester@oah.nc.gov	984-236-1938
Cathy Matthews-Thayer, Editorial Assistant	cathy.thayer@oah.nc.gov	984-236-1901

Rule Review and Legal Issues

Rules Review Commission
1711 New Hope Church Road — 984-236-1850
Raleigh, North Carolina 27609 — 984-236-1947 FAX

contact: Amber Cronk May, Commission Counsel	amber.may@oah.nc.gov	984-236-1936
Amanda Reeder, Commission Counsel	amanda.reeder@oah.nc.gov	984-236-1939
Ashley Snyder, Commission Counsel	ashley.snyder@oah.nc.gov	984-236-1941
Karlene Turrentine, Commission Counsel	karlene.turrentine@oah.nc.gov	984-236-1948
Alexander Burgos, Paralegal	alexander.burgos@oah.nc.gov	984-236-1940
Julie Brincefield, Administrative Assistant	julie.brincefield@oah.nc.gov	984-236-1935

Fiscal Notes & Economic Analysis

Office of State Budget and Management
116 West Jones Street
Raleigh, North Carolina 27603-8005
Contact: Carrie Hollis, Economic Analyst — osbmruleanalysis@osbm.nc.gov — 984-236-0689

NC Association of County Commissioners
215 North Dawson Street — 919-715-2893
Raleigh, North Carolina 27603
contact: Amy Bason — amy.bason@ncacc.org

NC League of Municipalities — 919-715-4000
150 Fayetteville Street, Suite 300
Raleigh, North Carolina 27601
contact: Sarah Collins — scollins@nclm.org

Legislative Process Concerning Rulemaking

545 Legislative Office Building
300 North Salisbury Street — 919-733-2578
Raleigh, North Carolina 27611 — 919-715-5460 FAX

Jason Moran-Bates, Staff Attorney
Jeremy Ray, Staff Attorney

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NORTH CAROLINA REGISTER

Publication Schedule for January 2020 – December 2020

FILING DEADLINES			NOTICE OF TEXT		PERMANENT RULE			TEMPORARY RULES
Volume & issue number	Issue date	Last day for filing	Earliest date for public hearing	End of required comment Period	Deadline to submit to RRC for review at next meeting	RRC Meeting Date	Earliest Eff. Date of Permanent Rule	270th day from publication in the Register
34:13	01/02/20	12/06/19	01/17/20	03/02/20	03/20/20	04/16/20	05/01/20	09/28/20
34:14	01/15/20	12/19/19	01/30/20	03/16/20	03/20/20	04/16/20	05/01/20	10/11/20
34:15	02/03/20	01/10/20	02/18/20	04/03/20	04/20/20	05/21/20	06/01/20	10/30/20
34:16	02/17/20	01/27/20	03/03/20	04/17/20	04/20/20	05/21/20	06/01/20	11/13/20
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34:18	03/16/20	02/24/20	03/31/20	05/15/20	05/20/20	06/18/20	07/01/20	12/11/20
34:19	04/01/20	03/11/20	04/16/20	06/01/20	06/22/20	07/16/20	08/01/20	12/27/20
34:20	04/15/20	03/24/20	04/30/20	06/15/20	06/22/20	07/16/20	08/01/20	01/10/21
34:21	05/01/20	04/09/20	05/16/20	06/30/20	07/20/20	08/20/20	09/01/20	01/26/21
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34:23	06/01/20	05/08/20	06/16/20	07/31/20	08/20/20	09/17/20	10/01/20	02/26/21
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35:08	10/15/20	09/24/20	10/30/20	12/14/20	12/21/20	01/21/21	02/01/21	07/12/21
35:09	11/02/20	10/12/20	11/17/20	01/04/21	01/20/21	02/18/21	03/01/21	07/30/21
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35:11	12/01/20	11/05/20	12/16/20	02/01/21	02/22/21	03/18/21	04/01/21	08/28/21
35:12	12/15/20	11/20/20	12/30/20	02/15/21	02/22/21	03/18/21	04/01/21	09/11/21

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EXPLANATION OF THE PUBLICATION SCHEDULE

This Publication Schedule is prepared by the Office of Administrative Hearings as a public service and the computation of time periods are not to be deemed binding or controlling. Time is computed according to 26 NCAC 2C .0302 and the Rules of Civil Procedure, Rule 6.

GENERAL

The North Carolina Register shall be published twice a month and contains the following information submitted for publication by a state agency:

(1) temporary rules;
(2) text of proposed rules;
(3) text of permanent rules approved by the Rules Review Commission;
(4) emergency rules
(5) Executive Orders of the Governor;
(6) final decision letters from the U.S. Attorney General concerning changes in laws affecting voting in a jurisdiction subject of Section 5 of the Voting Rights Act of 1965, as required by G.S. 120-30.9H; and
(7) other information the Codifier of Rules determines to be helpful to the public.

COMPUTING TIME: In computing time in the schedule, the day of publication of the North Carolina Register is not included. The last day of the period so computed is included, unless it is a Saturday, Sunday, or State holiday, in which event the period runs until the preceding day which is not a Saturday, Sunday, or State holiday.

FILING DEADLINES

ISSUE DATE: The Register is published on the first and fifteen of each month if the first or fifteenth of the month is not a Saturday, Sunday, or State holiday for employees mandated by the State Personnel Commission. If the first or fifteenth of any month is a Saturday, Sunday, or a holiday for State employees, the North Carolina Register issue for that day will be published on the day of that month after the first or fifteenth that is not a Saturday, Sunday, or holiday for State employees.

LAST DAY FOR FILING: The last day for filing for any issue is 15 days before the issue date excluding Saturdays, Sundays, and holidays for State employees.

NOTICE OF TEXT

EARLIEST DATE FOR PUBLIC HEARING: The hearing date shall be at least 15 days after the date a notice of the hearing is published.

END OF REQUIRED COMMENT PERIOD An agency shall accept comments on the text of a proposed rule for at least 60 days after the text is published or until the date of any public hearings held on the proposed rule, whichever is longer.

DEADLINE TO SUBMIT TO THE RULES REVIEW COMMISSION: The Commission shall review a rule submitted to it on or before the twentieth of a month by the last day of the next month.

(1)	Inflatables	$100.00	Annually
(2)	Rock ~~Walls~~ Walls, portable	$100.00	Annually
(3)	Kiddie Rides (48 inch maximum height restriction)	~~$45.00~~ $100.00	Every setup, except in permanent parks, which shall be inspected annually
(4)	Go Karts	~~$35.00~~ $50.00	Every setup, except in permanent parks, which shall be inspected annually
(5)	Go Kart Tracks	$100.00	Every setup, except in permanent parks, which shall be inspected annually
~~(5)~~(6)	Major Rides (any ride not otherwise listed herein) ~~and Water Slides~~	~~$90.00~~ $100.00	Every setup, except permanent parks, which shall be inspected annually
~~(6)~~(7)	Roller Coasters ~~Coasters, other than mobile or portable roller coasters~~	$250.00	Annually
(8)	Simulators, portable	$100.00	Every setup
(9)	Simulators, stationary	$100.00	Annually
(10)	Trains, small fixed track	$100.00	Annually
(11)	Waterslides	$150.00	Annually

Authority G.S. 95-107; 95-111.4(19).

13 NCAC 15 .0704 SPECIAL AMUSEMENT DEVICE INSPECTION FEE

(a) In the event that an inspection is scheduled and the amusement device operator or owner fails to have all amusement devices scheduled for inspection ready for inspection, any follow up inspection visits requested by the operator or owner shall be charged at two hundred fifty dollars ($250.00) per amusement device, notwithstanding the provisions of 13 NCAC 15 .0703.

(b) All inspections conducted outside normal business hours for the North Carolina Department of Labor ~~(7:00~~ (8:00 a.m. to 6:00 ~~7:00~~ p.m. Monday through Friday, exclusive of State government holidays) shall be charged at the rate of two hundred fifty dollars ($250.00) per inspection, plus the amusement device inspection fee, notwithstanding the provisions of 13 NCAC 15 .0703, however, in no instance may the total fee assessed exceed an aggregate of two hundred fifty dollars ($250.00) for each device inspected.

Authority G.S. 95-107; 95-111.4(19).

13 NCAC 15 .0705 PASSENGER TRAMWAY INSPECTION FEE SCHEDULE

Inspection fees for all passenger tramway devices shall be ~~as follows:~~ $137.00.

	~~Equipment~~	~~Unit Fee~~
~~(1)~~	~~Gondolas, Chairlifts, and Inclined Railroads~~	~~$137~~
~~(2)~~	~~J- or T-Bars and Conveyors~~	~~$62~~
~~(3)~~	~~Rope Tows~~	~~$31~~

Authority G.S. 95-120(9).

TITLE 15A – DEPARTMENT OF ENVIRONMENTAL QUALITY

***Notice** is hereby given in accordance with G.S. 150B-21.3A(c)(2)g. that the Marine Fisheries Commission intends to readopt with substantive changes the rules cited as 15A NCAC 18A .3401-.3405 and repeal through readoption the rules cited as 15A NCAC 18A .3406, and .3407.*

Link to agency website pursuant to G.S. 150B-19.1(c): *http://portal.ncdenr.org/web/mf/mfc-proposed-rules*

Proposed Effective Date: *April 1, 2021*

Public Hearing:
Date: *August 26, 2020*
Time: *6:00 p.m.*
Location: *In an abundance of caution and to address protective measures to help prevent the spread of COVID-19, this public hearing will be held by webinar. WebEx Events meeting link: https://ncdenrits.webex.com/ncdenrits/onstage/g.php?MTID=ea8608d0638d06136715b7a10b3dce68a*
Event number: 161 720 5186 Event password: 1234

Reason for Proposed Action: *The agency proposes five rules for readoption and two rules for repeal through readoption in accordance with G.S. 150B-21.3A for the Periodic Review and Expiration of Existing Rules. This is the first package of rules in 15A NCAC 18A for readoption over a four-year period. As part of the readoption process the agency is proposing changes to comply with the U.S. Environmental Protection Agency (EPA) performance criteria released in 2014. The program follows guidance set forth by the EPA in accordance with the E*

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Environmental Assessment Coastal Health Act (BEACH Act). The new guidance will increase efficiency in protecting public health and is recommending the same bacterial threshold for all swimming locations regardless of usage category. These bacteriological limits will impact how the agency issues public notifications when samples collected exceed the safe swimming standard.

Comments may be submitted to: *Catherine Blum, P.O. BOX 769, Morehead City, NC 28557; Written comments may also be submitted via an online form available at http://portal.ncdenr.org/web/mf/mfc-proposed-rules.*

Comment period ends: *October 2, 2020*

Procedure for Subjecting a Proposed Rule to Legislative Review: If an objection is not resolved prior to the adoption of the rule, a person may also submit written objections to the Rules Review Commission after the adoption of the Rule. If the Rules Review Commission receives written and signed objections after the adoption of the Rule in accordance with G.S. 150B-21.3(b2) from 10 or more persons clearly requesting review by the legislature and the Rules Review Commission approves the rule, the rule will become effective as provided in G.S. 150B-21.3(b1). The Commission will receive written objections until 5:00 p.m. on the day following the day the Commission approves the rule. The Commission will receive those objections by mail, delivery service, hand delivery, or facsimile transmission. If you have any further questions concerning the submission of objections to the Commission, please call a Commission staff attorney at 919-431-3000.

Fiscal impact. Does any rule or combination of rules in this notice create an economic impact? Check all that apply.

☒ **State funds affected**
☐ **Local funds affected**
☐ **Substantial economic impact (>= $1,000,000)**
☒ **Approved by OSBM**
☐ **No fiscal note required**

CHAPTER 18 - ENVIRONMENTAL HEALTH

SUBCHAPTER 18A - SANITATION

SECTION .3400 - COASTAL RECREATIONAL WATERS MONITORING, EVALUATION, AND NOTIFICATION

15A NCAC 18A .3401 DEFINITIONS

The following definitions shall apply ~~throughout~~ to Section ~~18A~~ .3400 of this Subchapter:

(1) "Division" means the Division of Marine Fisheries or its authorized agent.

~~(1)~~(2) "Enterococcus" means a gram positive coccoid-shaped bacteria that is found in the intestinal tracts of warm-blooded animals that include Enterococcus faecalis, Enterococcus faecium, Enterococcus avium, and Enterococcus gallinarium.

~~(2)~~(3) "Geometric mean" means the mean of "n" positive numbers obtained by taking the ~~"n"th~~ "nth" root of the product of the numbers with at least five samples collected within a ~~30 day~~ 30-day period.

(4) "Pending swimming advisory" means a notification to the public that recommends no primary contact with the water in a specific swimming area when bacteriological limits are exceeded but, does not close a swimming area to the public. A pending swimming advisory shall include a public notification via social media release to notify the public of the risks of swimming in the area. A pending swimming advisory is followed by a resample that will determine if a swimming advisory will be issued.

~~(3)~~(5) "Point source discharge" means the discharge of liquids through a pipe, drain, ~~ditch~~ ditch, or other conveyance into a swimming area.

~~(4)~~(6) "Primary contact" means an activity in water in which a person's head is partially or completely submerged.

(7) "Resample" means a water sample that is collected after the results of the initial water sample collected are processed and the results are analyzed.

~~(5)~~(8) "Storm water discharge" means any natural or manmade conveyance of rainwater or the resultant runoff into coastal recreational waters.

~~(6)~~(9) "Swimming advisory" means a notification to the public that recommends no primary contact with the water in a specific swimming area ~~for public health reasons~~ when bacteriological limits are exceeded, but does not close a swimming area to the public. A swimming advisory shall include a sign posted at the site of the advisory and a ~~press release~~ public notification via social media and news release to notify the public of the risks of swimming in the area.

~~(7) "Swimming alert" means a notification to the public by media contact including a press release to warn the public of risks of swimming in an area that exceeds bacteriological swimming area levels.~~

~~(8)~~(10) "Swimming area" means a coastal recreation area that is used for primary contact located within waters classified by the Division of Water ~~Quality~~ Resources as ~~SA, SB, or SC.~~ SC, SA, or SB as set forth in 15A NCAC 02B .0220-.0222, and is hereby incorporated by reference including subsequent amendments and editions.

~~(9)~~(11) "Swimming season" means from April 1 through October 31 of each year.

~~(10)~~(12) "Tier I swimming area" means a swimming area used daily during the swimming season, ~~including any public access swimming area and any other swimming area where people us~~

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~~water for primary contact,~~ including all oceanfront ~~beaches.~~ beaches that are monitored by the Division.

~~(11)~~(13) "Tier II swimming area" means a swimming area ~~used an average of three days a week~~ that is not used daily during the swimming season.

~~(12) "Tier III swimming area" means a swimming area used an average of four days a month during the swimming season.~~

~~(13)~~(14) "Winter season" means from November 1 through March 31 of each year.

Authority G.S. ~~130A-233.1;~~ 113-134; 113-182; 113-221.3; 143B-289.52.

15A NCAC 18A .3402 BACTERIOLOGICAL LIMITS FOR SWIMMING AREAS

(a) The enterococcus level in a Tier I swimming area shall not equal or exceed either:

(1) ~~A~~ a geometric mean of 35 enterococci per 100 ~~milliliter~~ milliliters of ~~water,~~ water; ~~that includes a minimum of at least five samples collected within 30 days;~~ or

(2) ~~A~~ a single sample of 104 enterococci per 100 ~~milliliter~~ milliliters of water.

(b) The enterococcus level in a Tier II swimming area shall not equal or exceed a single sample of ~~276~~ 104 enterococci per 100 ~~milliliter~~ milliliters of water.

~~(c) The enterococcus level in a Tier III swimming area shall not exceed two consecutive samples of 500 enterococci per 100 milliliter of water.~~

Authority G.S. ~~130A-233.1;~~ 113-134; 113-182; 113-221.3; 143B-289.52.

15A NCAC 18A .3403 PUBLIC NOTICE OF INCREASED HEALTH RISKS IN SWIMMING AREAS

(a) Tier I Swimming areas:

~~(1) A swimming advisory shall be issued by the Division when samples of water from a swimming area exceeds a geometric mean of 35 enterococci per 100 milliliter during the swimming season.~~

~~(2) A swimming alert shall be issued by the Division when a single sample of water from a swimming area exceeds 104 enterococci per 100 milliliter and does not exceed 500 enterococci per 100 milliliter during the swimming season.~~

~~(3) A swimming advisory shall be issued by the Division when a sample of water from a swimming area exceeds a single sample of 500 enterococci per 100 milliliter during the swimming season.~~

~~(4) A swimming advisory shall be issued by the Division when at least two of three concurrent water samples collected at a swimming area exceeds 104 enterococci per 100 milliliter during the swimming season.~~

(1) A pending swimming advisory shall be issued by the Division of Marine Fisheries if a water sample from a swimming area is equal to or exceeds the bacteriological limit set forth in Rule .3402(a)(2) of this Section, during the swimming season.

(2) A swimming advisory shall be issued by the Division if either of the following standards are exceeded during the swimming season:

(A) Both the initial water sample and resample collected from a swimming area is equal to or exceeds the bacteriological limit set forth in Rule .3402(a)(2) of this Section; or

(B) The most recent five water samples collected within a 30-day period from a swimming area is equal to or exceeds the bacteriological limit set forth in Rule .3402(a)(1) of this Section.

(b) Tier II swimming areas:

~~(1) A swimming alert shall be issued by the Division when a single sample of water from a swimming area exceeds 276 enterococci per 100 milliliter and does not exceed 500 enterococci per 100 milliliter during the swimming season.~~

(1) A pending swimming advisory shall be issued by the Division if a water sample from a swimming area is equal to or exceeds the bacteriological limit set forth in Rule .3402(a)(2) of this Section during the swimming season.

(2) A swimming advisory shall be issued by the Division ~~when a single sample~~ if both the initial water sample and resample collected ~~of water~~ from a swimming area is equal to or exceeds ~~500 enterococci per 100 milliliter~~ the bacteriological limit set forth in Rule .3402(a)(2) of this Section during the swimming season.

~~(c) A Tier III swimming area with a water sample result of 500 enterococci per 100 milliliter or higher on the first sample shall be resampled the following day. If the laboratory results of the second sample exceed 500 enterococci per 100 milliliter a swimming advisory shall be issued by the Division.~~

~~(d)~~(c) Signs posted pursuant to this Section shall be placed or erected in open view where the public may see the ~~sign(s)~~ sign prior to entering the water.

~~(e)~~(d) Signs shall ~~convey~~ state the following:

ATTENTION: SWIMMING IN THIS AREA IS NOT RECOMMENDED. BACTERIA TESTING INDICATES LEVELS OF CONTAMINATION THAT MAY BE HAZARDOUS TO YOUR HEALTH. THIS ADVISORY AFFECTS WATERS WITHIN 200' OF THIS SIGN. OFFICE OF THE STATE HEALTH DIRECTOR.

Authority G.S. ~~130A-233.1;~~ 113-134; 113-182; 113-221.3; 143B-289.52.

15A NCAC 18A .3404 SWIMMING ADVISORIES FOR POINT SOURCE DISCHARGES INTO SWIMMING AREAS

(a) A wastewater treatment plant that discharges into swimming waters shall be posted by the Division of Marine Fisheries with at least one sign until the discharge is removed. The ~~sign(s)~~ sign for a wastewater treatment plant discharge shall ~~convey~~ state the following:

> ~~ATTENTION: THESE WATERS MAY BE CONTAMINATED BY HUMAN OR ANIMAL WASTE. SWIMMING IS NOT ADVISED IN THESE WATERS BECAUSE OF THE INCREASED RISK OF ILLNESS. OFFICE OF THE STATE HEALTH DIRECTOR.~~
>
> WARNING! SEWAGE TREATMENT EFFLUENT DISCHARGE SITE. SWIMMING IS NOT ADVISED IN THESE WATERS BECAUSE OF THE INCREASED RISK OF ILLNESS. OFFICE OF THE STATE HEALTH DIRECTOR.

(b) A swimming advisory shall be issued by the Division and at least one sign shall be posted at the public access to swimming waters that have been impacted by a wastewater system failure. The sign for waters impacted by a wastewater spill shall state the following:

> WARNING! WASTEWATER SPILL. SWIMMING IS NOT ADVISED IN THESE WATERS BECAUSE OF THE INCREASED RISK OF ILLNESS. OFFICE OF THE STATE HEALTH DIRECTOR.

~~(b)~~(c) A swimming advisory shall be issued by the Division and at least ~~two signs~~ one sign shall be posted at a storm drain or storm water discharge that is ~~actively~~ discharging into a Tier 1 swimming area. ~~Signs~~ A sign shall be placed to advise the public as they enter the area impacted by the ~~drain.~~ storm drain or storm water discharge. For dry weather discharges, ~~The signs~~ the sign ~~for a storm drain or storm water discharge~~ shall ~~convey~~ state the following:

> ~~SWIMMING IS NOT RECOMMENDED BETWEEN SIGNS. WATERS MAY BE CONTAMINATED BY DISCHARGE FROM PIPE. OFFICE OF THE STATE HEALTH DIRECTOR.~~
>
> WARNING! STORM WATER DISCHARGE AREA. SWIMMING WITHIN 200 YARDS OF THIS SIGN MAY INCREASE THE RISKS OF WATERBORNE ILLNESS. OFFICE OF THE STATE HEALTH DIRECTOR.

For wet weather discharges, the sign shall state the following:

> WARNING! STORM WATER DISCHARGE AREA. WATERS MAY BE CONTAMINATED BY DISCHARGE FROM PIPE. SWIMMING IS NOT RECOMMENDED WITHIN 200 YARDS OF THIS SIGN DURING ACTIVE DISCHARGE. FOR MORE INFORMATION, CALL 252-726-6827. OFFICE OF THE STATE HEALTH DIRECTOR.

~~(c)~~(d) A swimming advisory shall be issued by the Division and at least two signs shall be posted at a storm drain where flood waters are being pumped into a swimming area. ~~The signs shall remain posted for at least 24 hours after the pumping of flood waters has ceased.~~ The signs shall ~~convey~~ state the following:

> SWIMMING IS NOT RECOMMENDED BETWEEN SIGNS. WATERS MAY BE CONTAMINATED BY DISCHARGE FROM PIPE. OFFICE OF THE STATE HEALTH DIRECTOR.

~~(d)~~(e) A swimming advisory shall be issued by the Division and at least two signs shall be posted at an area receiving dredge material on a swimming beach ~~when~~ if the dredge material is being pumped from an area closed to shellfish harvesting. The signs shall ~~convey~~ state the following:

> SWIMMING IS NOT RECOMMENDED BETWEEN SIGNS. WATERS MAY BE CONTAMINATED BY DISCHARGE FROM PIPE. OFFICE OF THE STATE HEALTH DIRECTOR.

Authority G.S. ~~130A-233.1;~~ 113-134; 113-182; 113-221.3; 143B-289.52.

15A NCAC 18A .3405 RESCINDING A PENDING SWIMMING ADVISORY OR SWIMMING ~~ALERT~~ ADVISORY

(a) A pending swimming advisory shall be rescinded by the Division of Marine Fisheries via social media release when the resample collected meets the bacteriological limit set forth in Rule .3402(a)(2) of this Section.

~~(a)~~(b) A Tier I swimming area advisory shall be rescinded by the Division via social media and news release, including the removal of signs, when ~~two consecutive weekly water samples and the geometric mean meet the bacteriological limits in Rule 18A .3402(a) of this Section. A swimming alert shall be rescinded within 24 hours of compliance with Rule 18A .3402(a)(2) of this Section.~~ both of the following conditions are met:

(1) The geometric mean has met the bacteriological limit set forth in Rule .3402(a)(1) of this Section.

(2) Two consecutive weekly water samples meet the bacteriological limit set forth in Rule .3402(a)(2) of this Section.

~~(b)~~(c) A Tier II ~~or Tier III~~ swimming area advisory ~~or alert~~ shall be rescinded by the Division via social media and news release, including the removal of signs, after water samples meet the bacteriological ~~standard in Rule 18A .3402(b) or (c) of this Section.~~ limit set forth in Rule .3402(b) of this Section.

~~(c)~~(d) A swimming advisory resulting from a ~~point source~~ flood water discharge or the discharge of dredge material shall be rescinded by the Division via social media and news release 24 hours after the discharge has ~~ceased.~~ ceased, to allow for tidal dispersion.

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(e) A swimming advisory resulting from a wastewater system failure shall be rescinded by the Division via social media and news release, including the removal of signs, when failure has been corrected and water samples collected meet the bacteriological limit set forth in Rule .3402(a)(2) of this Section.
~~(d) When a swimming advisory or alert has been rescinded, the Division shall issue a press release to announce the lifting of the advisory or the alert and the sign(s) shall be removed immediately by the Division.~~

Authority G.S. ~~130A-233.1;~~ 113-134; 113-182; 113-221.3; 143B-289.52.

15A NCAC 18A .3406 DESTRUCTION OF SIGNS
~~A person shall not mutilate, deface, pull down, destroy, hide, or steal any sign posted pursuant to this Section.~~

Authority G.S. 130A-233.1.

15A NCAC 18A .3407 APPLICABILITY OF RULES
~~The rules of this Section shall apply to all marine recreational waters in coastal North Carolina.~~

Authority G.S. 130A-233.1.

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MARINE FISHERIES COMMISSION
SUMMARY OF PUBLIC HEARING FOR PROPOSED RULES
DIVISION OF MARINE FISHERIES
WEBEX ONLINE HEARING
AUG. 26, 2020, 6 PM

Marine Fisheries Commission:	None
Division of Marine Fisheries Staff:	Catherine Blum, Erin Bryan-Millush, Corrin Flora, Dana Gillikin, Shannon Jenkins, Lara Klibansky, Shawn Nelson
Public:	Kerri Allen, Larry Baldwin, Jeff Manning, Annie Mercer, Nicole Triplett
Media:	None

Division of Marine Fisheries Rulemaking Coordinator Catherine Blum, serving as the hearing officer, opened the public hearing for Marine Fisheries Commission proposed rules at 6 p.m. There were five members of the public in attendance. She explained the agency is proposing five rules for readoption cited as 15A NCAC 18A .3401-.3405 and two rules for repeal through readoption cited as 15A NCAC 18A .3406 and .3407 in accordance with G.S. 150B-21.3A for the Periodic Review and Expiration of Existing Rules.

Mrs. Blum said public comments on the proposed rules will be presented to the Marine Fisheries Commission at its Nov. 18-20, 2020 meeting prior to its vote on final approval of the rules. Written comments will be accepted through Oct. 2. She reviewed guidelines of the public hearing process and explained the hearing is a formal process to receive public comments only about the proposed rules as published in the *N.C. Register*.

Mrs. Blum reviewed the proposed rules by explaining the reason for proposed action for the seven rules as published in Volume 35, Issue 03 of the *N.C. Register*. She opened the floor for the public to provide comments. No one in attendance provided comments. Mrs. Blum closed the hearing at 6:08 p.m.

/cb

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North Carolina
Coastal Federation
Working Together for a Healthy Coast

September 14, 2020

N.C. Marine Fisheries Commission
Recreational Water Quality Rules Comments
P.O Box 769
Morehead City, NC 28557

Re: Marine Fisheries Commission Proposed Rules 2020-2021 Package A Recreational Water Quality Program Rules

Dear Commission members:

On behalf of the North Carolina Coastal Federation (federation), please accept the following comments on the Marine Fisheries Commission's proposed amendments and re-adoption of Coastal Recreational Water Quality Program Rules. The federation supports the proposed amendments brought forth for review, and respectfully requests the Commission's consideration of additional enhancements, as outlined in this letter.

The federation is a non-profit organization dedicated to protecting and restoring the North Carolina coast. Our organization represents 16,000 supporters statewide and works with the public, agencies and local governments to communicate and collaborate wherever possible towards solutions that lead to the stewardship and resiliency of our coast. Since 1982, the federation has been working with coastal communities and other partners to improve and protect coastal water quality and natural habitats, which are intricately tied to our coastal economy. By focusing primarily, but not exclusively on natural and productive estuarine shorelines, oyster and marsh restoration, coastal management and cleaning the estuaries of marine debris, we strive to support and enhance the coastal natural environment.

Clean coastal waters that support fishing and swimming are the foundation for our coastal environment and economy. As presented, the proposed amendments strengthen state rules within 15A NCAC 18A .3400 for both residents and visitors. The new language ensures equal protection for swimmers by requiring the same bacteriological threshold triggers for public health advisories for all swimming locations, regardless of usage frequency. By consolidating tiers and issuing advisories in Tier II with just one exceedance of the now lowered standard, more protection will be afforded to users.

As written, the proposed modifications to the swimming advisory notification process will also reduce delays and confusion. The draft language for wastewater and stormwater discharge sites, as well as that for wastewater spills, will improve clarity and ultimately, human health. North Carolina swimming waters are enjoyed by hundreds of thousands of

Northeast Region
637 Harbor Road, P.O. Box 276
Wanchese, NC 27981
252.473.1607

Headquarters & Central Region
3609 N.C. 24 □ Newport, NC 28570
252.393.8185
www.nccoast.org

Southeast Region
309 W. Salisbu
Wrightsville Beach, N
910.5

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residents from all across the state each year. Oftentimes, visitors to these coastal areas do not understand the risks associated with swimming in affected waters, and rely upon state and local government to adequately inform and protect. Making sure advisories are sufficiently advertised and posting signage that clearly explains risks is paramount to not only public health but also to the coastal economy.

The federation represents thousands of North Carolinians who drink, fish, swim, and paddle the state's waters. These users place a high value on the quality of water resources; however, current environmental protection measures are often insufficient and additional protections are necessary to prevent further degradation. In addition to the proposed amendments, the federation respectfully brings the following items to the Commission's attention for consideration:

1) The federation encourages the Commission to adopt a more inclusive definition of *primary contact* that is consistent with EPA standards.

   As written in 15A NCAC 18A .3401, *primary contact* is defined as "an activity in water in which a person's head is partially or completely submerged."

   Under §304(a)(l) of the Clean Water Act, the Administrator of the EPA is directed to develop and publish water quality criteria that accurately reflect the latest scientific knowledge on the kind and extent of all identifiable effects on health and welfare that might be expected from the presence of pollutants in any body of water. Within the most recent Recreational Water Quality Criteria, EPA describes *primary contact* recreation as typically including activities where immersion and ingestion are likely and there is a high degree of bodily contact with the water, such as swimming, bathing, surfing, water skiing, tubing, skin diving, water play by children, or similar water-contact activities.[1]

   Based upon EPA language, we recommend the Commission adopt a more robust definition of *primary contact* that reflects all possible water-contact activities, not just those in which an individual's head is submerged.

2) The federation encourages the Commission to post at all stormwater outfalls, regardless of use or tier designation when active discharges of water are occurring.

   As written in 15A NCAC 18A .3404, swimming advisories and signage are required at a storm drain or storm water discharge that is actively discharging into a Tier I swimming area, but there is no mention of actions associated with Tier II sites. The federation contends that warning and protecting the public at stormwater outfalls is the responsibility of the state, regardless of usage volume.

   Furthermore, there should be an active notification requirement for advisories from the abovementioned stormwater outfalls whenever they discharge stormwater.

[1] https://www.epa.gov/sites/production/files/2015-10/documents/rwqc2012.pdf

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Since public advisories are only issued in the presence of/as a result of sampling data (as outlined in 15A NCAC 18A .3403), the public is not notified of the health risks posed from active stormwater conveyances. Advisories should be posted when discharges take place to avoid public health threats that result from contaminants released from flows occurring between sampling events.

3) The federation encourages the Commission to close swimming areas and impose enforceable swimming bans when bacteriological limits are exceeded.

   As described in 15A NCAC 18A .3401, swimming advisories provide notifications to the public that recommends no primary contact with the water in a specific swimming area for public health reasons when bacteriological limits are exceeded, but does not close a swimming area to the public.

   Nationwide, ample precedent exists to close swimming areas when bacteriological limits are exceeded. A report generated from the EPA's Beach Advisory and Closing On-line Notification tool (BEACON) identified 11 different coastal states that have issued swimming closures as a result of elevated bacterial levels over the last 25 years.[2]

   In Rhode Island for example, the Department of Health works to determine whether the water at state beaches is safe for swimming, and imposes closures when exceedances of more than 60 cfu/100 mL in saltwater and in freshwater are reported. As a result, 51 beach closures have occurred to date in Rhode Island this year.[3]

   Precedence exists within North Carolina, as well; North Carolina State Parks close swimming areas each year for a number of public health and safety reasons, including poor water quality. The mission of the North Carolina Recreational Water Quality Program is to protect the public health by monitoring the quality of North Carolina's coastal recreational waters and notifying the public when bacteriological standards for safe bodily contact are exceeded.[4]

   As such, the federation affirms that it is the responsibility of the state to protect the public health not only by monitoring the quality of North Carolina's coastal waters, but also by imposing actionable closures.

4) The federation encourages the Commission to post advisories and signage in English and Spanish.

[2] https://watersgeo.epa.gov/beacon2/

[3] https://health.ri.gov/data/beaches/

[4] http://portal.ncdenr.org/web/mf/recreational-water-quality

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The federation believes that all people deserve to live, work and play in healthy and safe places, and that everyone should have a voice in management decisions that affect the future of their coastal communities.

North Carolina's Hispanic population is nearing 1 million, with 932,000 residents in 2016.[5] Statewide, over 9% of North Carolina's population is Spanish-speaking and North Carolina is one of only eight states nationwide to require labor laws to be posted in Spanish, as well as English.[6]

Through the federation's own work within the 20 coastal counties, it is well established that many subsistence fishers speak only Spanish and rely on the state's coastal waters to supplement their food budget. Any new signage published by the federation includes Spanish translations, and work continues to engage these vital populations in ongoing conservation and restoration efforts.

The Commission should follow the lead of conservation and equity groups across the country to foster inclusion and protect the public health by posting advisories and signage in English and Spanish to protect all users.

Thank you for the opportunity to comment on these important changes, and for your ongoing work to safeguard our communities and environment. Together with the help of the Commission, the federation continues to work towards a natural, beautiful and productive coast that is a great place to live, work and visit.

Sincerely,

Kerri Allen

Kerri Allen,
Coastal Advocate

[5] https://www.ncdemography.org/2017/10/10/the-hispaniclatino-community-in-north-carolina/
[6] https://www.labor.nc.gov/labor-law-posters

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RULEMAKING UPDATE

PACKAGE B

2020-2021 ANNUAL RULEMAKING CYCLE TABLE

OCTOBER 1 NEWS RELEASE

NC REGISTER PUBLICATION OF PROPOSED RULES

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N.C. Marine Fisheries Commission
2020-2021 Annual Rulemaking Cycle
Package B

November 2020

Time of Year	Action
February-July 2020	Fiscal analysis of rules prepared by DMF staff and approved by Office of State Budget and Management
August 2020	MFC approves Notice of Text for Rulemaking
October 2020	Publication of proposed rules in the *North Carolina Register*
October-November 2020	Public comment period held
Oct. 21 and 27, 2020	Public hearings held via WebEx
February 2021	MFC considers approval of permanent rules
March 2021	Rules reviewed by Office of Administrative Hearings/ Rules Review Commission
April 1, 2021 *or* TBD	Proposed effective date of rules; some rules are subject to legislative review per S.L. 2019-198 and G.S. 14-4.1.
April 1, 2021	Rulebook supplement available online
April 15, 2021	Commercial license sales begin

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Roy Cooper
Governor

Michael S. Regan
Secretary

Steve Murphey
Director

Release: Immediate
Date: Oct. 1, 2020

Contact: Patricia Smith
Phone: 252-726-7021

MEDIA ADVISORY: Comment period opens, public hearings scheduled for various marine fisheries rules

MOREHEAD CITY – The N.C. Marine Fisheries Commission is accepting public comment on proposed amendments and re-adoption of 50 rules under a state-mandated periodic review schedule.

Most of the rules pertain to shellfish lease user conflicts, reclassification of Special Secondary Nursery Areas, oyster sanctuaries, classification of shellfish growing waters, and sanitation standards for commercial crustacea processing procedures.

Other rules pertaining to joint fishing waters are proposed for re-adoption with no changes.

Two public hearings will be held by web conference on Oct. 21 at 6 p.m. and on Oct. 27 at 6 p.m. The public may join the meetings online; however, those who wish to comment during the hearing must register to speak by noon on the day of the hearing.

Members of the public also may submit written comments through an online form or through the mail to N.C. Marine Fisheries Commission Recreational Water Quality Rules Comments, P.O Box 769, Morehead City, N.C. 28557. Comments must be posted online or be received by the N.C. Division of Marine Fisheries by 5 p.m. Nov. 30, 2020.

Links to the public hearing registration form and online comment form, as well as text of the proposed rules and links to join the meeting, can be found on the N.C. Marine Fisheries Commission's Proposed Rules Page.

The N.C. Marine Fisheries Commission proposes re-adoption of a portion of rules in 15A NCAC 03O (shellfish lease user conflicts), 15A NCAC 03Q (joint fishing waters), 15A NCAC 03R (Special Secondary Nursery Areas and oyster sanctuaries), and 15A NCAC 18A (shellfish growing waters and shellfish sanitation and processing). Proposed rule changes will:

- Address user conflicts associated with shellfish leases while supporting a productive shellfish aquaculture industry, as required by NCGA Session Law 2019-37. The proposed changes will increase setback requirements from developed shorelines for new shellfish leases; limit the allowable number of corner markers for demarcating shellfish leases to simplify the polygon shapes; set new criteria for shellfish lease stakes and signage to alleviate navigation concerns; and, initiate a new shellfish leaseholder training program that emphasizes user conflict reduction strategies.
- Reclassify nine Special Secondary Nursery Areas to Secondary Nursery Areas, as recommended by the Shrimp Fishery Management Plan Amendment 1. The nine areas have not been opened to trawling since at least 2004, so there will be no effective change to the shrimp trawl fishery; however, the reclassification will result in a small mesh gill net attendance requirement in these waters, except for Scranton Creek. All areas have gill net attendance requirements now; the proposed rules would require additional attendance in all waters, not just 50 yards from the shoreline, from May 1 to Nov. 30.
- Amend the oyster sanctuaries rule by adding five new sites (Long Shoal, Little Creek, Pea Island, Raccoon Island, and Swan Island), updating boundaries for three existing sites (Neuse River, West Bluff, and Gibbs Shoal), and removing two sites that no longer function as sanctuaries (Ocracoke and Clam Shoal).

Website: http://www.ncdenr.gov
Facebook: http://www.facebook.com/ncdeq
Twitter: http://twitter.com/NCDEQ
RSS Feed: http://portal.ncdenr.org/web/opa/news-releases-rss
1601 Mail Service Center, Raleigh, NC 27699-1601

- Update shellfish sanitation laboratory procedures, sanitation survey reporting requirements, standards for classifying shellfish waters, and definitions to conform with current national standards.
- Readopt with no changes nine rules that pertain to joint fishing waters, in accordance with a state-mandated periodic review schedule.
- Correct grammar, typographical errors, and update agency names.

The proposed rule changes will be presented to the N.C. Marine Fisheries Commission for final approval in February 2021 and have an earliest effective date of April 1, 2021.

For questions about the N.C. Marine Fisheries Commission rulemaking process, email Catherine Blum, rules coordinator for the N.C. Division of Marine Fisheries.

WHO:	Marine Fisheries Commission
WHAT:	Two Public Hearings for Proposed Rules
WHEN:	Oct. 21 at 6 p.m. Oct. 27 at 6 p.m.
WHERE:	Meeting by Web Conference Click Here for Information and to Sign Up to Speak

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NORTH CAROLINA
REGISTER

VOLUME 35 • ISSUE 07 • Pages 702 – 821

October 1, 2020

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Contact List for Rulemaking Questions or Concerns

For questions or concerns regarding the Administrative Procedure Act or any of its components, consult with the agencies below. The bolded headings are typical issues which the given agency can address but are not inclusive.

Rule Notices, Filings, Register, Deadlines, Copies of Proposed Rules, etc.

Office of Administrative Hearings
Rules Division
1711 New Hope Church Road — 984-236-1850
Raleigh, North Carolina 27609 — 984-236-1947 FAX

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Dana McGhee, Publications Coordinator	dana.mcghee@oah.nc.gov	984-236-1937
Lindsay Silvester, Editorial Assistant	lindsay.silvester@oah.nc.gov	984-236-1938
Cathy Matthews-Thayer, Editorial Assistant	cathy.thayer@oah.nc.gov	984-236-1901

Rule Review and Legal Issues

Rules Review Commission
1711 New Hope Church Road — 984-236-1850
Raleigh, North Carolina 27609 — 984-236-1947 FAX

contact: Amber Cronk May, Commission Counsel	amber.may@oah.nc.gov	984-236-1936
Amanda Reeder, Commission Counsel	amanda.reeder@oah.nc.gov	984-236-1939
Ashley Snyder, Commission Counsel	ashley.snyder@oah.nc.gov	984-236-1941
Karlene Turrentine, Commission Counsel	karlene.turrentine@oah.nc.gov	984-236-1948
Alexander Burgos, Paralegal	alexander.burgos@oah.nc.gov	984-236-1940
Julie Brincefield, Administrative Assistant	julie.brincefield@oah.nc.gov	984-236-1935

Fiscal Notes & Economic Analysis

Office of State Budget and Management
116 West Jones Street
Raleigh, North Carolina 27603-8005
Contact: Carrie Hollis, Economic Analyst — osbmruleanalysis@osbm.nc.gov — 984-236-0689

NC Association of County Commissioners
215 North Dawson Street — 919-715-2893
Raleigh, North Carolina 27603
contact: Amy Bason — amy.bason@ncacc.org

NC League of Municipalities — 919-715-4000
150 Fayetteville Street, Suite 300
Raleigh, North Carolina 27601
contact: Sarah Collins — scollins@nclm.org

Legislative Process Concerning Rulemaking

545 Legislative Office Building
300 North Salisbury Street — 919-733-2578
Raleigh, North Carolina 27611 — 919-715-5460 FAX

Jason Moran-Bates, Staff Attorney
Jeremy Ray, Staff Attorney

NORTH CAROLINA REGISTER

Publication Schedule for January 2020 – December 2020

FILING DEADLINES			NOTICE OF TEXT		PERMANENT RULE			TEMPORARY RULES
Volume & issue number	Issue date	Last day for filing	Earliest date for public hearing	End of required comment Period	Deadline to submit to RRC for review at next meeting	RRC Meeting Date	Earliest Eff. Date of Permanent Rule	270th day from publication in the Register
34:13	01/02/20	12/06/19	01/17/20	03/02/20	03/20/20	04/16/20	05/01/20	09/28/20
34:14	01/15/20	12/19/19	01/30/20	03/16/20	03/20/20	04/16/20	05/01/20	10/11/20
34:15	02/03/20	01/10/20	02/18/20	04/03/20	04/20/20	05/21/20	06/01/20	10/30/20
34:16	02/17/20	01/27/20	03/03/20	04/17/20	04/20/20	05/21/20	06/01/20	11/13/20
34:17	03/02/20	02/10/20	03/17/20	05/01/20	05/20/20	06/18/20	07/01/20	11/27/20
34:18	03/16/20	02/24/20	03/31/20	05/15/20	05/20/20	06/18/20	07/01/20	12/11/20
34:19	04/01/20	03/11/20	04/16/20	06/01/20	06/22/20	07/16/20	08/01/20	12/27/20
34:20	04/15/20	03/24/20	04/30/20	06/15/20	06/22/20	07/16/20	08/01/20	01/10/21
34:21	05/01/20	04/09/20	05/16/20	06/30/20	07/20/20	08/20/20	09/01/20	01/26/21
34:22	05/15/20	04/24/20	05/30/20	07/14/20	07/20/20	08/20/20	09/01/20	02/09/21
34:23	06/01/20	05/08/20	06/16/20	07/31/20	08/20/20	09/17/20	10/01/20	02/26/21
34:24	06/15/20	05/22/20	06/30/20	08/14/20	08/20/20	09/17/20	10/01/20	03/12/21
35:01	07/01/20	06/10/20	07/16/20	08/31/20	09/21/20	10/15/20	11/01/20	03/28/21
35:02	07/15/20	06/23/20	07/30/20	09/14/20	09/21/20	10/15/20	11/01/20	04/11/21
35:03	08/03/20	07/13/20	08/18/20	10/02/20	10/20/20	11/19/20	12/01/20	04/30/21
35:04	08/17/20	07/27/20	09/01/20	10/16/20	10/20/20	11/19/20	12/01/20	05/14/21
35:05	09/01/20	08/11/20	09/16/20	11/02/20	11/20/20	12/17/20	01/01/21	05/29/21
35:06	09/15/20	08/24/20	09/30/20	11/16/20	11/20/20	12/17/20	01/01/21	06/12/21
35:07	10/01/20	09/10/20	10/16/20	11/30/20	12/21/20	01/21/21	02/01/21	06/28/21
35:08	10/15/20	09/24/20	10/30/20	12/14/20	12/21/20	01/21/21	02/01/21	07/12/21
35:09	11/02/20	10/12/20	11/17/20	01/04/21	01/20/21	02/18/21	03/01/21	07/30/21
35:10	11/16/20	10/23/20	12/01/20	01/15/21	01/20/21	02/18/21	03/01/21	08/13/21
35:11	12/01/20	11/05/20	12/16/20	02/01/21	02/22/21	03/18/21	04/01/21	08/28/21
35:12	12/15/20	11/20/20	12/30/20	02/15/21	02/22/21	03/18/21	04/01/21	09/11/21

EXPLANATION OF THE PUBLICATION SCHEDULE

This Publication Schedule is prepared by the Office of Administrative Hearings as a public service and the computation of time periods are not to be deemed binding or controlling. Time is computed according to 26 NCAC 2C .0302 and the Rules of Civil Procedure, Rule 6.

GENERAL

The North Carolina Register shall be published twice a month and contains the following information submitted for publication by a state agency:

(1) temporary rules;
(2) text of proposed rules;
(3) text of permanent rules approved by the Rules Review Commission;
(4) emergency rules
(5) Executive Orders of the Governor;
(6) final decision letters from the U.S. Attorney General concerning changes in laws affecting voting in a jurisdiction subject of Section 5 of the Voting Rights Act of 1965, as required by G.S. 120-30.9H; and
(7) other information the Codifier of Rules determines to be helpful to the public.

COMPUTING TIME: In computing time in the schedule, the day of publication of the North Carolina Register is not included. The last day of the period so computed is included, unless it is a Saturday, Sunday, or State holiday, in which event the period runs until the preceding day which is not a Saturday, Sunday, or State holiday.

FILING DEADLINES

ISSUE DATE: The Register is published on the first and fifteen of each month if the first or fifteenth of the month is not a Saturday, Sunday, or State holiday for employees mandated by the State Personnel Commission. If the first or fifteenth of any month is a Saturday, Sunday, or a holiday for State employees, the North Carolina Register issue for that day will be published on the day of that month after the first or fifteenth that is not a Saturday, Sunday, or holiday for State employees.

LAST DAY FOR FILING: The last day for filing for any issue is 15 days before the issue date excluding Saturdays, Sundays, and holidays for State employees.

NOTICE OF TEXT

EARLIEST DATE FOR PUBLIC HEARING: The hearing date shall be at least 15 days after the date a notice of the hearing is published.

END OF REQUIRED COMMENT PERIOD
An agency shall accept comments on the text of a proposed rule for at least 60 days after the text is published or until the date of any public hearings held on the proposed rule, whichever is longer.

DEADLINE TO SUBMIT TO THE RULES REVIEW COMMISSION: The Commission shall review a rule submitted to it on or before the twentieth of a month by the last day of the next month.

General	50% of the otherwise applicable fee	$25
General Title V ACI	10% of the otherwise applicable fee	

(Note: fees shaded in gray are fees for calendar year 2020, not adjusted for inflation for 2021)

Permit application fees for Title V facilities shall be adjusted for inflation as described in 15A NCAC 02Q .0204. ~~The current permit application fees shall be found on the Division's website at https://deq.nc.gov/about/divisions/air-quality/air-quality-permits/modifying-applying-for-air-quality-permit.~~

(e) The current annual permit fees, annual complexity fees, and permit application fees shall be found on the Division's website at https://deq.nc.gov/about/divisions/air-quality/air-quality-permits/modifying-applying-for-air-quality-permit.

~~(c)~~(f) If a facility, other than a general facility, belongs to more than one facility category, the fees shall be those of the applicable category with the highest fees. If a permit application belongs to more than one type of application, the fee shall be that of the applicable permit application type with the highest fee.

~~(d)~~(g) The tonnage factor fee shall be applicable only to Title V facilities. It shall be computed by multiplying the tonnage factor indicated in the table in Paragraph (a) of this Rule by the facility's combined total actual emissions of all regulated air pollutants, rounded to the nearest ton, contained in the latest emissions inventory that has been completed by the Division. The calculation shall not ~~include:~~ include the amount of actual emissions of each pollutant that exceeds 4,000 tons per year and the actual emissions of pollutants listed in Subparagraphs (1) through (4) of this Paragraph as follows:

(1) carbon monoxide;

(2) any pollutant that is regulated solely because it is a Class I or II substance listed pursuant to Section 602 of the federal Clean Air Act (ozone depletors);

(3) any pollutant that is regulated solely because it is subject to a regulation or standard pursuant to Section 112(r) of the federal Clean Air Act (accidental releases); and

~~(4) the amount of actual emissions of each pollutant that exceeds 4,000 tons per year.~~

(4) greenhouse gases.

Even though a pollutant may be classified in more than one pollutant category, the amount of pollutant emitted shall be counted only once for tonnage factor fee purposes and in a pollutant category chosen by the permittee. If a facility has more than one permit, the tonnage factor fee for the facility's combined total actual emissions as described in this Paragraph shall be paid only on the permit whose anniversary date first occurs on or after July 1.

~~(e)~~(h) The nonattainment area added fee shall be applicable only to Title V facilities required to comply with 15A NCAC 02D .0531 (Sources in Nonattainment Areas), 15A NCAC 02D .0900 (Volatile Organic Compounds), or 15A NCAC 02D .1400 (Nitrogen Oxides) and either:

(1) are in an area designated in 40 CFR 81.334 as nonattainment, or

(2) are covered by a nonattainment or maintenance State Implementation Plan submitted for approval or approved as part of 40 CFR Part 52, Subpart II.

~~(f)~~(i) The facility category, Title V (PSD or NSR/NAA), in the permit application fees table in Paragraph ~~(b)~~(d) of this Rule means a facility whose application shall be subject to review pursuant to 15A NCAC 02D .0530 (Prevention of Significant Deterioration) or 15A NCAC 02D .0531.

~~(g)~~(j) The facility category, Title V (PSD and NSR/NAA), in the permit application fees table in Paragraph ~~(b)~~(d) of this Rule means a facility whose application shall be subject to review pursuant to 15A NCAC 02D .0530 and .0531.

~~(h)~~(k) Minor modification permit applications that are group processed shall require the payment of only one permit application fee per facility included in the group.

~~(i)~~(l) No permit application fee shall be required for renewal of an existing permit, for changes to an unexpired permit when the only reason for the changes is initiated by the Director or the Commission, for a name change with no ownership change, for a change pursuant to 15A NCAC 02Q .0523 (Changes Not Requiring Permit Revisions), or for a construction date change, a test date change, a reporting procedure change, or a similar change.

~~(j)~~(m) The permit application fee paid for modifications pursuant to 15A NCAC 02Q .0400, Acid Rain Procedures, shall be the fee for the same modification if it were subject to 15A NCAC 02Q .0500, Title V Procedures.

~~(k)~~(n) An applicant who files permit applications pursuant to 15A NCAC 02Q .0504 shall pay an application fee equal to the application fee for the permit required pursuant to 15A NCAC 02Q .0500; this fee shall cover both applications, provided that the second application covers only what is covered under the first application. If permit terms or conditions in an existing or future permit issued pursuant to 15A NCAC 02Q .0500 are established or modified by an application for a modification and if these terms or conditions are enforceable by the Division only, then the applicant shall pay the fee under the column entitled "Minor Modification" in the table in Paragraph ~~(b)~~(d) of this Rule.

Authority G.S. 143-215.3(a)(1),(1a),(1b),(1d).

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***Notice** is hereby given in accordance with G.S. 150B-21.2 and G.S. 150B-21.3A(c)(2)g. that the Marine Fisheries Commission intends to amend the rules cited as 15A NCAC 03R .0104, .0117, readopt with substantive changes the rules cited as 15A NCAC 03O .0201, .0202, .0204; 03R .0105; 18A .0146, .0150, .0154, .0155, .0159, .0160, .0167, .0171, .0172, .0179, .0180, .0189, .0190, .0704, .0901-.0907, .0909, .0913, .0914, readopt without substantive changes the rules cited as 15A NCAC 03Q .0101-.0109; 18A .0140-.0143, .0163, .0169, .0170, .0188, and repeal through readoption the rules cited as 15A NCAC 18A .0431, .0908, and .0910.*

Link to agency website pursuant to G.S. 150B-19.1(c): *http://portal.ncdenr.org/web/mf/mfc-proposed-rules*

Proposed Effective Date:
15A NCAC 03O .0204; 03Q .0107: automatically subject to legislative review (S.L. 2019-198)
All other rules: April 1, 2021

Public Hearing: *In an abundance of caution and to address protective measures to help prevent the spread of COVID-19, these public hearings will be held by webinar.*

Date: *October 21, 2020*
Time: *6:00 p.m.*
Location: *WebEx Events meeting link for Oct. 21: https://ncdenrits.webex.com/ncdenrits/onstage/g.php?MTID=e9643b0b8096a03f9e8e7aedc69f00aa5*
Event number for Oct. 21: 171 042 8393 Event password for Oct. 21: 1234

Date: *October 27, 2020*
Time: *6:00 p.m.*
Location: *WebEx Events meeting link for Oct. 27: https://ncdenrits.webex.com/ncdenrits/onstage/g.php?MTID=e9c38fe4cfb0d9fc1c4e4d02a818988ce*
Event number for Oct. 27: 171 724 2813 Event password for Oct. 27: 1234

Reason for Proposed Action:
15A NCAC 03O .0201 STANDARDS AND REQUIREMENTS FOR SHELLFISH BOTTOM LEASES AND FRANCHISES AND WATER COLUMN LEASES
15A NCAC 03O .0202 SHELLFISH BOTTOM AND WATER COLUMN LEASE APPLICATIONS
15A NCAC 03O .0204 MARKING SHELLFISH LEASES AND FRANCHISES
In accordance with G.S. 150B-21.3A and Session Law 2019-37, proposed amendments to these three rules aim to reduce user conflict issues while supporting a productive shellfish aquaculture industry. Specifically, the amendments proposed would increase setback limits from developed shorelines for new shellfish leases, limit the allowable number of corners for demarcating shellfish leases to simplify polygon shape, set new criteria for shellfish lease stakes and signage to alleviate navigation concerns, and initiate a new leaseholder training program that emphasizes user conflict reduction strategies. Session Law 2019-37 was passed with the explicit goal of providing increased support to the state's shellfish aquaculture industry. Central to this was the goal of understanding user conflict issues of shellfish leasing and amending state regulations based on these findings. Section 9 of the law required the N.C. Department of Environmental Quality, N.C. Division of Marine Fisheries, and the N.C. Marine Fisheries Commission to study how to reduce user conflict related to shellfish cultivation leases, and to adopt rules and reform internal operating procedures consistent with the findings of the study. Proposed rule amendments are based on the results of the study.

15A NCAC 03Q .0101 SCOPE AND PURPOSE
15A NCAC 03Q .0102 INLAND FISHING WATERS
15A NCAC 03Q .0103 COASTAL FISHING WATERS
15A NCAC 03Q .0104 JOINT FISHING WATERS
15A NCAC 03Q .0105 POSTING DIVIDING LINES
15A NCAC 03Q .0106 APPLICABILITY OF RULES: JOINT WATERS
15A NCAC 03Q .0107 SPECIAL REGULATIONS: JOINT WATERS
15A NCAC 03Q .0108 MANAGEMENT RESPONSIBILITY FOR ESTUARINE STRIPED BASS IN JOINT WATERS
15A NCAC 03Q .0109 IMPLEMENTATION OF ESTUARINE STRIPED BASS MANAGEMENT PLANS: RECREATIONAL FISHING
In accordance with G.S. 150B-21.3A, these nine rules that pertain to the classification of the waters of North Carolina as coastal fishing waters, inland fishing waters, and joint fishing waters are proposed for readoption by the N.C. Marine Fisheries Commission with no changes.

15A NCAC 03R .0104 PERMANEMENT SECONDARY NURSERY AREAS
15A NCAC 03R .0105 SPECIAL SECONDARY NURSERY AREAS
In accordance with G.S. 150B-21.3A (15A NCAC 03R .0105) and the N.C. Shrimp Fishery Management Plan (FMP) Amendment 1 (both rules), proposed amendments to these two rules reclassify nine Special Secondary Nursery Areas (SSNAs) as Secondary Nursery Areas (SNAs). In 2015, the N.C. Marine Fisheries Commission adopted the Shrimp FMP Amendment 1. One of the final management measures to implement after adoption of Amendment 1 was to evaluate changing the designation of nine SSNAs that have not been opened to trawling since at least 2004 to SNAs. The evaluation was undertaken and shows these nine sites have all been functioning as SNAs for nearly 30 years. None of these sites has been opened for trawling since 1991 at the latest, except for one site (Newport River), which was opened by proclamation in 2004. These changes would convert approximately 8,670 acres of current SSNA waters to SNAs, making them subject to all standard SNA gill net attendance requirements under 03R .0112(b)(1). The two practical differences between SNAs and SSNAs relates to trawling and small mesh gill net attendance. In SNAs, it is unlawful to use trawl nets for any purpose, but since none of the proposed SSNAs has been opened to trawling since at least 2004, the only impactful management change is the new requirements related to small mesh gill net attendance in all but one of these waters. (Scranton Creek would see no changes in its small mesh gill net attendance requirements.) Appendix III of the fiscal analysis of the proposed rules contains tables and figures for the nine areas that shows the gill net attendance requirements that would be in place once the rule changes become effective.

15A NCAC 03R .0117 OYSTER SANCTUARIES
This rule is proposed for amendment consistent with the N.C. Oyster Fishery Management Plan. Rule amendments are proposed to add the boundaries of the five most recently developed oyster sanctuaries (i.e., Long Shoal, Little Creek, Pea Island, Raccoon Island, and Swan Island) and update boundaries for three existing sanctuaries (i.e., Neuse River, West Bluff, and Gibbs Shoal). Boundaries delineating the area for two existing sanctuaries (i.e., Ocracoke and Clam Shoal) are proposed

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removed from rule as they no longer function as biologically productive oyster sanctuaries. The term "sanctuary" refers to reefs protected from oyster harvest in N.C. Marine Fisheries Commission (MFC) rule or by proclamation issued by the Fisheries Director under the authority of MFC rule.

15A NCAC 18A .0140 FLOORS
15A NCAC 18A. 0141 WALLS AND CEILINGS
15A NCAC 18A .0142 LIGHTING
15A NCAC 18A .0143 VENTILATION
15A NCAC 18A .0163 COOKED CRUSTACEA REFRIGERATION
15A NCAC 18A .0169 FREEZING
15A NCAC 18A .0170 SHIPPING
15A NCAC 18A .0188 HAZARD ANALYSIS

In accordance with G.S. 150B-21.3A, these eight rules that relate to standards for commercial shellfish sanitation and processing procedures are proposed for readoption with no changes.

15A NCAC 18A .0146 PREMISES
15A NCAC 18A .0150 SEWAGE DISPOSAL
15A NCAC 18A .0154 EMPLOYEES' PERSONAL ARTICLES
15A NCAC 18A .0155 SUPPLY STORAGE
15A NCAC 18A .0159 SEPARATION OF OPERATIONS
15A NCAC 18A .0160 RAW CRUSTACEA RECEIVING AND REFRIGERATION
15A NCAC 18A .0167 DELIVERY WINDOW OR SHELF
15A NCAC 18A .0171 WHOLE CRUSTACEA OR CRUSTACEA PRODUCTS
15A NCAC 18A .0172 COOKED CLAW SHIPPING CONDITIONS
15A NCAC 18A .0179 RECALL PROCEDURE
15A NCAC 18A .0180 SAMPLING AND TESTING
15A NCAC 18A .0189 HACCP PLAN
15A NCAC 18A .0190 SANITATION MONITORING REQUIREMENTS

In accordance with G.S. 150B-21.3A, these 13 rules that relate to standards for commercial shellfish sanitation and processing procedures are proposed for readoption with minor changes, such as updates to punctuation, agency names, capitalization, acronym introduction, and a missing degree symbol for a temperature provided.

15A NCAC 18A .0431 STANDARDS FOR AN APPROVED SHELLFISH GROWING AREA

In accordance with G.S. 150B-21.3A, this rule is proposed for repeal, as it is redundant with rule 15A NCAC 18A .0904.

15A NCAC 18A .0704 LABORATORY PROCEDURES
15A NCAC 18A .0914 LABORATORY PROCEDURES

In accordance with G.S. 150B-21.3A, the proposed amendments replace an outdated set of standards for the types of laboratories and laboratory methods that can be used to support the North Carolina Shellfish Sanitation and Recreational Water Quality Section with a set of standards that will bring North Carolina rules into agreement with current national standards, and will better protect the health of shellfish consumers. These amendments will also provide North Carolina with additional flexibility regarding the types of laboratory tests that are permissible for use within the program.

15A NCAC 18A .0901 DEFINITIONS

In accordance with G.S. 150B-21.3A, the proposed amendments update definitions to conform with proposed changes to other rules in 15A NCAC 18A .0900.

15A NCAC 18A .0902 CLASSIFICATION OF SHELLFISH GROWING WATERS

In accordance with G.S. 150B-21.3A, the proposed amendments eliminate the interchangeable use of two differently defined terms, "shellfish growing waters" and "shellfish growing areas", in order to improve the clarity of what this rule requires.

15A NCAC 18A .0903 SANITARY SURVEYS
15A NCAC 18A .0910 RECLASSIFICATION

In accordance with G.S. 150B-21.3A, the proposed amendments update the reporting requirements that need to be met in order to classify shellfish growing waters or to modify existing classifications, and to bring those requirements in line with the national standards. The proposed amendments include details on the required frequency of reporting as well as the required contents of each report. Rule .0910 is proposed for repeal, with the requirements of the rule being moved into .0903 instead, for improved clarity and organization.

15A NCAC 18A .0904 APPROVED WATERS

In accordance with G.S. 150B-21.3A, the proposed amendments replace an outdated set of standards used for the classification of shellfish harvesting waters with a set of standards that would bring North Carolina rules into agreement with current national requirements, and would better protect the health of shellfish consumers. These amendments would also provide North Carolina with additional flexibility regarding the types of laboratory tests that are permissible for use in the classification of shellfish growing waters.

15A NCAC 18A .0905 CONDITIONALLY APPROVED WATERS

In accordance with G.S. 150B-21.3A, the proposed amendments define the criteria that must be met in order to classify shellfish growing waters with the conditionally approved classification. They would also bring North Carolina rules into agreement with current national requirements by defining the required contents of management plans that must be developed for any conditionally approved waters, and by adding in the requirement that all conditionally approved growing waters be re-evaluated on an annual basis to ensure that the classification remains appropriate.

15A NCAC 18A .0906 RESTRICTED AREAS

In accordance with G.S. 150B-21.3A, the proposed amendments define the criteria that must be met in order to classify shellfish growing waters with the restricted classification. They would also bring North Carolina rules into agreement with current national requirements by defining the specific bacteriological standards that must be met for restricted waters to be used as a source of shellstock for depuration.

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15A NCAC 18A .0907 PROHIBITED WATERS
15A NCAC 18A .0908 UNSURVEYED AREAS
15A NCAC 18A .0909 BUFFER ZONE

In accordance with G.S. 150B-21.3A, the proposed amendments replace an outdated set of standards and requirements used for the prohibited classification of shellfish harvesting waters with a set of standards and requirements that would bring North Carolina rules into agreement with current national requirements, and would better protect the health of shellfish consumers. These modifications would also reduce redundancy between rules. The requirements contained in .0908 are redundant with and better suited for inclusion in .0907, so .0908 is proposed for repeal.

15A NCAC 18A .0913 PUBLIC HEALTH EMERGENCY

In accordance with G.S. 150B-21.3A, the proposed amendments update the language in the rule to reflect that the Shellfish Sanitation and Recreational Water Quality Section is now part of the Division of Marine Fisheries, instead of the Division of Environmental Health.

Comments may be submitted to: *Catherine Blum, P.O. BOX 769, Morehead City, NC 28557*
Written comments may also be submitted via an online form available at http://portal.ncdenr.org/web/mf/mfc-proposed-rules.

Comment period ends: *November 30, 2020*

Procedure for Subjecting a Proposed Rule to Legislative Review: If an objection is not resolved prior to the adoption of the rule, a person may also submit written objections to the Rules Review Commission after the adoption of the Rule. If the Rules Review Commission receives written and signed objections after the adoption of the Rule in accordance with G.S. 150B-21.3(b2) from 10 or more persons clearly requesting review by the legislature and the Rules Review Commission approves the rule, the rule will become effective as provided in G.S. 150B-21.3(b1). The Commission will receive written objections until 5:00 p.m. on the day following the day the Commission approves the rule. The Commission will receive those objections by mail, delivery service, hand delivery, or facsimile transmission. If you have any further questions concerning the submission of objections to the Commission, please call a Commission staff attorney at 919-431-3000.

Fiscal impact. Does any rule or combination of rules in this notice create an economic impact? Check all that apply.

- ☒ **State funds affected**
- ☒ **Local funds affected**
- ☐ **Substantial economic impact (>= $1,000,000)**
- ☒ **Approved by OSBM**
- ☐ **No fiscal note required**

CHAPTER 03 - MARINE FISHERIES

SUBCHAPTER 03O - LICENSES, LEASES, FRANCHISES AND PERMITS

SECTION .0200 – LEASES AND FRANCHISES

15A NCAC 03O .0201 STANDARDS AND REQUIREMENTS FOR SHELLFISH BOTTOM LEASES AND FRANCHISES AND WATER COLUMN LEASES

(a) All areas of the public bottom underlying Coastal Fishing Waters shall meet the following standards and requirements, in addition to the standards in G.S. 113-202, in order to be deemed suitable for leasing for shellfish cultivation purposes:

(1) the proposed lease area shall not contain a "natural shellfish bed," as defined in G.S. 113-201.1, or have 10 bushels or more of shellfish per acre;

(2) the proposed lease area shall not be closer than ~~100~~ 250 feet ~~to~~ from a developed ~~shoreline,~~ shoreline or a water-dependent shore-based structure, except no minimum setback is required when the area to be leased borders the applicant's property, the property of "riparian owners" as defined in G.S. 113-201.1 who have consented in a notarized statement, or is in an area bordered by undeveloped ~~shoreline; and~~ shoreline. For the purposes of this Rule, a water-dependent shore-based structure shall include docks, wharves, boat ramps, bridges, bulkheads, and groins;

(3) the proposed lease area shall not be closer than 250 feet to an existing shellfish lease;

(4) the proposed lease area, either alone or when considered cumulatively with existing shellfish leases in the area, shall not interfere with navigation or with existing, traditional uses of the area; and

~~(3)~~(5) the proposed lease area shall not be less than one-half acre and shall not exceed 10 acres.

(b) To be suitable for leasing for aquaculture purposes, water columns superjacent to leased bottom shall meet the standards in G.S. 113-202.1 and water columns superjacent to franchises recognized pursuant to G.S. 113-206 shall meet the standards in G.S. 113-202.2.

(c) Franchises recognized pursuant to G.S. 113-206 and shellfish bottom leases shall be terminated unless they meet the following requirements, in addition to the standards in and as allowed by G.S. 113-202:

(1) they produce and market 10 bushels of shellfish per acre per year; and

(2) they are planted with 25 bushels of seed shellfish per acre per year or 50 bushels of cultch per acre per year, or a combination of cultch and seed shellfish where the percentage of required cultch planted and the percentage of required seed shellfish planted totals at least 100 percent.

(d) Water column leases shall be terminated unless they meet the following requirements, in addition to the standards in and as allowed by G.S. 113-202.1 and 113-202.2:

(1) they produce and market 40 bushels of shellfish per acre per year; or

(2) the underlying bottom is planted with 100 bushels of cultch or seed shellfish per acre per year.

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(e) The following standards shall be applied to determine compliance with Paragraphs (c) and (d) of this Rule:

(1) Only shellfish marketed, planted, or produced as defined in 15A NCAC 03I .0101 as the fishing activities "shellfish marketing from leases and franchises," "shellfish planting effort on leases and franchises," or "shellfish production on leases and franchises" shall be included in the lease and franchise reports required by Rule .0207 of this Section.

(2) If more than one lease or franchise is used in the production of shellfish, one of the leases or franchises used in the production of the shellfish shall be designated as the producing lease or franchise for those shellfish. Each bushel of shellfish shall be produced by only one lease or franchise. Shellfish transplanted between leases or franchises shall be credited as planting effort on only one lease or franchise.

(3) Production and marketing information and planting effort information shall be compiled and averaged separately to assess compliance with the requirements of this Rule. The lease or franchise shall meet both the production requirement and the planting effort requirement within the dates set forth in G.S. 113-202.1 and G.S. 202.2 to be deemed in compliance for shellfish bottom leases. The lease or franchise shall meet either the production requirement or the planting effort requirement within the dates set forth in G.S. 113-202.1 and G.S. 202.2 to be deemed in compliance for water column leases.

(4) All bushel measurements shall be in standard U.S. bushels.

(5) In determining production and marketing averages and planting effort averages for information not reported in bushel measurements, the following conversion factors shall be used:

(A) 300 oysters, 400 clams, or 400 scallops equal one bushel; and

(B) 40 pounds of scallop shell, 60 pounds of oyster shell, 75 pounds of clam shell, or 90 pounds of fossil stone equal one bushel.

(6) Production and marketing rate averages shall be computed irrespective of transfer of the lease or franchise. The production and marketing rates shall be averaged for the following situations using the time periods described:

(A) for an initial bottom lease or franchise, over the consecutive full calendar years remaining on the bottom lease or franchise contract after December 31 following the second anniversary of the initial bottom lease or franchise;

(B) for a renewal bottom lease or franchise, over the consecutive full calendar years beginning January 1 of the final year of the previous bottom lease or franchise term and ending December 31 of the final year of the current bottom lease or franchise contract;

(C) for a water column lease, over the first five-year period for an initial water column lease and over the most recent five-year period thereafter for a renewal water column lease; or

(D) for a bottom lease or franchise issued an extension period under Rule .0208 of this Section, over the most recent five-year period.

(7) In the event that a portion of an existing lease or franchise is obtained by a new owner, the production history for the portion obtained shall be a percentage of the originating lease or franchise production equal to the percentage of the area of lease or franchise site obtained to the area of the originating lease or franchise.

(f) Persons holding five or more acres under all shellfish bottom leases and franchises combined shall meet the requirements established in Paragraph (c) of this Rule before submitting an application for additional shellfish lease acreage to the Division of Marine Fisheries.

Authority G.S. 113-134; 113-182; 113-201; 113-202; 113-202.1; 113-202.2; 113-206; 143B-289.52.

15A NCAC 03O .0202 SHELLFISH BOTTOM AND WATER COLUMN LEASE APPLICATIONS

(a) Application forms are available from the ~~Division's office headquarters at~~ Division of Marine Fisheries, 3441 Arendell Street, Morehead City, NC 28557 for persons desiring to apply for shellfish bottom and water column leases. Each application shall be accompanied by a map or diagram prepared at the applicant's expense including an inset vicinity map showing the location of the proposed lease with detail sufficient to permit on-site identification and ~~must~~ shall meet the information requirements pursuant to G.S. 113-202(d).

(b) As a part of the application, the applicant shall submit a ~~management plan~~ Shellfish Lease Management Plan for the area to be leased on a form provided by the Division ~~which meets the following standards:~~ that shall:

(1) ~~States~~ state the methods through which the applicant will cultivate and produce shellfish consistent with the minimum requirements ~~set forth in 15A NCAC 03O .0201;~~ in accordance with Rule .0201 of this Section;

(2) ~~States~~ state the time intervals during which various phases of the cultivation and production plan will be achieved;

(3) ~~States~~ state the materials and techniques that will be utilized in management of the lease;

(4) ~~Forecasts~~ forecast the results expected to be achieved by the management activities; ~~and~~

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(5) ~~Describes~~ describe the productivity of any other leases or franchises held by the ~~applicant.~~ applicant; and

(6) state the locations of each corner defining the area to be leased with no more than eight corners.

(c) The completed application, map or diagram, and ~~management plan~~ Shellfish Lease Management Plan for the requested lease shall be accompanied by the non-refundable filing fee set forth in G.S. 113-202(d1). An incomplete application shall be returned and not considered further until re-submitted complete with all required information.

(d) Applicants and transferees not currently holding a shellfish cultivation lease, and applicants and transferees holding one or more shellfish cultivation leases which are not meeting production requirements, shall complete ~~and submit an examination, with a minimum of 70 percent correct answers, based on an educational package~~ the Shellfish Aquaculture Education Program provided by the ~~Division of Marine Fisheries.~~ Division. The ~~examination~~ Shellfish Aquaculture Education Program shall ~~demonstrate the applicant's knowledge of:~~ provide the applicant information on shellfish aquaculture including:

~~(1) the shellfish lease application process;~~

~~(2) shellfish lease planting and production requirements;~~

~~(3) lease marking requirements;~~

~~(4) lease fees;~~

~~(5) shellfish harvest area closures due to pollution;~~

~~(6) safe handling practices;~~

~~(7) lease contracts and renewals;~~

~~(8) lease termination criteria; and~~

~~(9) shellfish cultivation techniques.~~

(1) shellfish lease application process;

(2) shellfish lease requirements and techniques;

(3) shellfish sanitation and National Shellfish Sanitation Program requirements;

(4) shellfish harvest requirements;

(5) aquaculture permits;

(6) best management practices; and

(7) shellfish lease user conflict avoidance.

(e) After an application is deemed to have met all requirements and is accepted by the Division, the applicant shall identify the area for which a lease is requested with stakes at each corner in accordance with ~~15A NCAC 03O .0204(a)(1)(A).~~ Rule .0204(a)(1)(A) of this Section. The applicant shall attach to each stake a sign, provided by the Division containing the name of the applicant, the date the application was filed, and the estimated acres. The applicant shall be responsible for ensuring the sign remains in place until the lease application process is completed.

Authority G.S. 113-134; 113-182; 113-201; 113-202; 143B-289.52.

15A NCAC 03O .0204 MARKING SHELLFISH LEASES AND WATER COLUMN LEASES AND FRANCHISES

(a) All shellfish bottom leases, franchises, and water column leases shall be marked by the leaseholder or franchise holder as follows:

(1) Shellfish bottom leases and franchises shall be marked by:

(A) ~~Stakes~~ stakes of wood or plastic material ~~at least three inches in diameter~~ no less than three inches in diameter and no more than 12 inches in diameter at the ~~water level~~ mean high water mark and extending at least four feet above the mean high water ~~mark.~~ mark for each corner, except stakes more than 12 inches in diameter approved as part of a Coastal Area Management Act Permit issued in accordance with G.S. 113A-118 and G.S. 113-229 shall be allowed. The stakes shall be firmly jetted or driven into the bottom at each ~~corner.~~ corner as set forth in Rule .0202(b)(6) of this Section.

(B) ~~Signs~~ signs displaying the number of the lease or franchise and the name of the owner printed in letters at least three inches high must be firmly attached to each corner stake.

(C) yellow light reflective tape or yellow light reflective devices on each corner stake. The yellow light reflective tape or yellow light reflective devices shall be affixed to each corner stake, shall cover a vertical distance of not less than 12 inches, and shall be visible from all directions.

~~(C)~~(D) ~~Supplementary~~ supplementary stakes of wood or plastic ~~material,~~ material no less than three inches in diameter and no more than four inches in diameter, not farther apart than ~~50 yards~~ 150 feet or closer together than 50 feet and extending at least four feet above the mean high water mark, ~~must~~ shall be placed along each boundary, except ~~when such would interfere~~ if doing so interferes with the use of traditional navigation channels.

(2) ~~Water~~ Shellfish water column leases shall be marked ~~by anchoring two yellow buoys, meeting the material and minimum size requirements specified in 15A NCAC 3J .0103(b)~~ at each corner of the area ~~or by larger buoys, posts and~~ by signs giving notice and providing caution in addition to the required signs as identified and approved by the Secretary in the ~~Management Plan.~~ management plan.

(b) Stakes marking areas of management within shellfish bottom leases or franchises, as approved in the management plan, ~~must~~ shall conform to ~~Subparagraph (a)(1)(C)~~ Part (a)(1)(D) of this Rule and may not exceed one for each 1,200 square feet. Marking at concentrations of stakes greater than one for each 1,200 s

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feet constitutes use of the water column and a water column lease is required in accordance with G.S. 113-202.1 or G.S. 113-202.2.
(c) All areas claimed in filings made pursuant to G.S. 113-205 as deeded bottoms through oyster grants issued by the county clerk of court or as private bottoms through perpetual franchises issued by the Shellfish Commission shall be marked in accordance with Paragraph (a) of this Rule, except the sign shall include the number of the franchise rather than the number of the lease. However, claimed areas not being managed and cultivated shall not be marked.
~~(d) It is unlawful to fail to remove all stakes, signs, and markers within 30 days of receipt of notice from the Secretary pursuant to Departmental Rule 15A NCAC 1G .0207 that a G.S. 113-205 claim to a marked area has been denied.~~
~~(e)~~(d) It ~~is~~ shall be unlawful to exclude or attempt to exclude the public from allowable public trust use of navigable waters on shellfish leases and franchises including, but not limited to, fishing, hunting, swimming, ~~wading~~ wading, and navigation.
~~(f)~~(e) The Division has no duty to protect any shellfish bottom lease, franchise, or water column lease not marked in accordance with Paragraph (a) of this Rule.

Authority G.S. 76-40; 113-134; 113-182; 113-201; 113-202; 113-202.1; 113-202.2; 113-205.

SUBCHAPTER 03Q - JURISDICTION OF AGENCIES: CLASSIFICATION OF WATERS

SECTION .0100 - GENERAL REGULATIONS: JOINT

15A NCAC 03Q .0101 SCOPE AND PURPOSE
The rules in this Section pertain to the classification of the waters of North Carolina as coastal fishing waters, inland fishing waters and joint fishing waters. These rules are adopted jointly by the Marine Fisheries Commission and the Wildlife Resources Commission. In addition to the classification of the waters of the state these joint rules set forth guidelines to determine which fishing activities in joint waters are regulated by the Marine Fisheries Commission and which are regulated by the Wildlife Resources Commission. Finally, the joint rules set forth special fishing regulations applicable in joint waters that can be enforced by officers of the Division of Marine Fisheries and the Wildlife Resources Commission. These regulations do not affect the jurisdiction of the Marine Fisheries Commission and the Wildlife Resources Commission in any matters other than those specifically set out.

Authority G.S. 113-132; 113-134; 143B-289.52.

15A NCAC 03Q .0102 INLAND FISHING WATERS
Inland fishing waters are all inland waters except private ponds; and all waters connecting with or tributary to coastal sounds or the ocean extending inland from the dividing line between coastal fishing waters and inland fishing waters agreed upon by the Marine Fisheries Commission and the Wildlife Resources Commission. All waters which are tributary to inland fishing waters and which are not otherwise designated by agreement between the Marine Fisheries Commission and the Wildlife Resources Commission are inland fishing waters. The regulation and licensing of fishing in inland fishing waters is under the jurisdiction of the Wildlife Resources Commission. Regulations and laws administered by the Wildlife Resources Commission regarding fishing in inland fishing waters are enforced by wildlife enforcement officers.

Authority G.S. 113-132; 113-134; 143B-289.52.

15A NCAC 03Q .0103 COASTAL FISHING WATERS
Coastal fishing waters are the Atlantic Ocean; the various coastal sounds; and estuarine waters up to the dividing line between coastal fishing waters and inland fishing waters agreed upon by the Marine Fisheries Commission and the Wildlife Resources Commission. All waters which are tributary to coastal fishing waters and which are not otherwise designated by agreement between the Marine Fisheries Commission and the Wildlife Resources Commission are coastal fishing waters. The regulations and licensing of fishing in coastal fishing waters is under the jurisdiction of the Marine Fisheries Commission; except that inland game fish (exclusive of spotted seatrout, weakfish, and striped bass) are subject to regulations by the Wildlife Resources Commission in coastal fishing waters. Regulations and laws administered by the Marine Fisheries Commission regarding fishing in coastal waters are enforced by fisheries enforcement officers. Regulations regarding inland game fish in coastal fishing waters are enforced by wildlife enforcement officers unless otherwise agreed to by the Wildlife Resources Commission.

Authority G.S. 113-132; 113-134; 143B-289.52.

15A NCAC 03Q .0104 JOINT FISHING WATERS
Joint fishing waters are those coastal fishing waters, hereinafter set out, denominated by agreement of the Marine Fisheries Commission and the Wildlife Resources Commission pursuant to G.S. 113-132(e) as joint fishing waters. All waters which are tributary to joint fishing waters and which are not otherwise designated by agreement between the Marine Fisheries Commission and the Wildlife Resources Commission are classified as joint fishing waters. The regulation and licensing of fishing in joint waters shall be as stated in 15A NCAC 3Q .0106.

Authority G.S. 113-132; 113-134; 143B-289.52.

15A NCAC 03Q .0105 POSTING DIVIDING LINES
The dividing lines of all major bodies of water and watercourses which are divided by the agreement of the Marine Fisheries Commission and the Wildlife Resources Commission so that portions of the same are constituted inland fishing waters, coastal fishing waters, or joint fishing waters shall be marked with signs in so far as may be practicable. Unmarked and undesignated tributaries shall have the same classification as the designated waters to which they connect or into which they flow. No unauthorized removal or relocation of any such marker shall have the effect of changing the classification of any body of water or portion thereof, nor shall any such unauthorized removal or relocation or the absence of any marker affect the applicability of any regulation pertaining to any such body of water or portion thereof.

Authority G.S. 113-132; 113-134; 143B-289.52.

15A NCAC 03Q .0106 APPLICABILITY OF RULES: JOINT WATERS

(a) All coastal fishing laws and regulations administered by the Department of Environment and Natural Resources and the Marine Fisheries Commission apply to joint waters except as otherwise provided, and shall be enforced by fisheries enforcement officers.

(b) The following inland fishing laws and regulations administered by the Wildlife Resources Commission apply to joint waters and shall be enforced by wildlife enforcement officers:

(1) all laws and regulations pertaining to inland game fishes,

(2) all laws and regulations pertaining to inland fishing license requirements for hook and line fishing,

(3) all laws and regulations pertaining to hook and line fishing except as hereinafter provided.

Authority G.S. 113-132; 113-134; 143B-289.52.

15A NCAC 03Q .0107 SPECIAL REGULATIONS: JOINT WATERS

In order to effectively manage all fisheries resources in joint waters and in order to confer enforcement powers on both fisheries enforcement officers and wildlife enforcement officers with respect to certain rules, the Marine Fisheries Commission and the Wildlife Resources Commission deem it necessary to adopt special rules for joint waters. Such rules supersede any inconsistent rules of the Marine Fisheries Commission or the Wildlife Resources Commission that would otherwise be applicable in joint waters under the provisions of 15A NCAC 03Q .0106:

(1) Striped Bass

(a) It is unlawful to possess any striped bass or striped bass hybrid that is less than 18 inches long (total length).

(b) It is unlawful to possess striped bass or striped bass hybrids between the lengths of 22 and 27 inches (total length) in joint fishing waters of the Central Southern Management Area as designated in 15A NCAC 03R .0201.

(c) It is unlawful to possess striped bass or striped bass hybrids May through September in the joint fishing waters of the Central Southern Management Area and the Albemarle Sound Management Area.

(d) It is unlawful to possess striped bass or striped bass hybrids taken from the joint fishing waters of the Cape Fear River.

(e) It is unlawful to possess more than one daily creel limit of striped bass or striped bass hybrids, in the aggregate, per person per day, regardless of the number of management areas fished.

(f) Possession of fish shall be assessed for the creel and size limits of the management area in which the individual is found to be fishing, regardless of the size or creel limits for other management areas visited by that individual in a given day.

(g) It is unlawful to engage in net fishing for striped bass or striped bass hybrids in joint waters except as authorized by rules of the Marine Fisheries Commission.

(2) Lake Mattamuskeet:

(a) It is unlawful to set or attempt to set any gill net in Lake Mattamuskeet canals designated as joint waters.

(b) It is unlawful to use or attempt to use any trawl net or seines in Lake Mattamuskeet canals designated as joint waters.

(3) Cape Fear River. It is unlawful to use or attempt to use any net, net stakes or electrical fishing device within 800 feet of the dam at Lock No.1 on the Cape Fear River.

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

Authority G.S. 113-132; 113-134; 143B-289.52.

15A NCAC 03Q .0108 MANAGEMENT RESPONSIBILITY FOR ESTUARINE STRIPED BASS IN JOINT WATERS

(a) The management areas for estuarine striped bass fisheries in coastal North Carolina are designated in 15A NCAC 03R .0201.

(b) In order to effectively manage the recreational hook and line harvest in joint waters of the Albemarle Sound-Roanoke River stock of striped bass, the Marine Fisheries Commission and the Wildlife Resources Commission deem it necessary to establish two management areas; the Albemarle Sound Management Area and the Roanoke River Management Area as designated in 15A NCAC 03R .0201. The Wildlife Resources Commission shall have principal management responsibility for the stock when it is in the joint and inland fishing waters of the Roanoke River Management Area. The Marine Fisheries Commission shall have principal management responsibility for the stock in the coastal, joint and inland waters of the Albemarle Sound Management Area. The annual quota for recreational harvest of the Albemarle-Roanoke striped bass stock shall be divided equally between the two management areas. Each commission shall implement management actions for recreational harvest within their respective management areas that will be consistent with the North Carolina Estuarine Striped Bass Fishery Management Plan.

Authority G.S. 113-132; 113-134; 143B-289.52.

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15A NCAC 03Q .0109 IMPLEMENTATION OF ESTUARINE STRIPED BASS MANAGEMENT PLANS: RECREATIONAL FISHING

The Marine Fisheries and Wildlife Resources Commissions shall implement their respective striped bass management actions for recreational fishing pursuant to their respective rule-making powers. To preserve jurisdictional authority of each Commission, the following means are established through which management measures can be implemented by a single instrument in the following management areas:

(1) In the Roanoke River Management Area, the exclusive authority to open and close seasons and areas, and establish size and creel limits whether inland or joint fishing waters shall be vested in the Wildlife Resources Commission. An instrument closing any management area in joint waters shall operate as and shall be a jointly issued instrument opening or closing seasons or areas to harvest in the Roanoke River management area.

(2) In the Albemarle Sound Management Area, the exclusive authority to open and close seasons and areas and establish size and creel limits, whether coastal or joint fishing waters shall be vested in the Marine Fisheries Commission. The season shall close by proclamation if the quota is about to be exceeded. In the Albemarle Sound Management Area administered by the Marine Fisheries Commission, a proclamation affecting the harvest in joint and coastal waters, excluding the Roanoke River Management Area, shall automatically be implemented and effective as a Wildlife Resources Commission action in the inland waters and tributaries to the waters affected.

Authority G.S. 113-132; 113-134; 113-182; 143B-289.52.

SUBCHAPTER 03R - DESCRIPTIVE BOUNDARIES

SECTION .0100 - DESCRIPTIVE BOUNDARIES

15A NCAC 03R .0104 PERMANENT SECONDARY NURSERY AREAS

The permanent secondary nursery areas referenced in 15A NCAC 03N .0105(a) are delineated in the following coastal water areas:

(1) Roanoke Sound:
Inner Shallowbag Bay - west of a line beginning on the northeast shore at a point 35° 54.6729' N – 75° 39.8099' W; running southerly to the southeast shore to a point 35° 54.1722' N – 75° 39.6806' W;

(2) ~~In~~ in the Pamlico Long Sound Area:

(a) Long Shoal River - north of a line beginning at the 5th Avenue Canal at a point 35° 35.2120' N – 75° 53.2232' W; running easterly to the east shore on Pains Point to a point 35° 35.0666' N – 75° 51.2000' W;

(b) Pains Bay - east of a line beginning on Pains Point at a point 35° 35.0666' N – 75° 51.2000' W; running southerly to Rawls Island to a point 35° 34.4666' N – 75° 50.9666' W; running easterly to the east shore to a point 35° 34.2309' N – 75° 50.2695' W;

(c) Wysocking Bay - northwest of a line beginning at Benson Point at a point 35° 22.9684' N – 76° 03.7129' W; running northeasterly to Long Point to a point 35° 24.6895' N – 76° 01.3155' W;

(d) Juniper Bay-Cunning Harbor - north of a line beginning on the west shore of Juniper Bay at a point 35° 20.6217' N – 76° 15.5447' W; running easterly to a point 35° 20.4372' N – 76° 13.2697' W; running easterly to the east shore of Cunning Harbor to a point 35° 20.3413' N – 76° 12.3378' W;

(e) Swanquarter Bay - north of a line beginning at The Narrows at a point 35° 20.9500' N – 76° 20.6409' W; running easterly to the east shore to a point 35° 21.5959' N – 76° 18.3580' W;

(f) Deep Cove - The Narrows - north and east of a line beginning on the west shore at a point 35° 20.9790' N – 76° 23.8577' W; running southeasterly to Swanquarter Island to a point 35° 20.5321' N – 76° 22.7869' W; and west of a line at The Narrows beginning on the north shore to a point 35° 20.9500' N – 76° 20.6409' W; running southerly to Swanquarter Island to a point 35° 20.7025' N – 76° 20.5620' W;

(g) Rose Bay - north of a line beginning on Long Point at a point 35° 23.3404' N – 76° 26.2491' W; running southeasterly to Drum Point to a point 35° 22.4891' N – 76° 25.2012' W;

(h) Spencer Bay - northwest of a line beginning on Roos Point at a point 35° 22.3866' N – 76° 27.9225' W; running northeasterly to Long Point to a point 35° 23.3404' N – 76° 26.2491' W;

(i) Abel Bay - northeast of a line beginning on the west shore at a point 35° 23.6463' N – 76° 31.0003' W; running southeasterly to the east shore to a point 35° 22.9353' N – 76° 29.7215' W;

(j) Mouse Harbor - west of a line beginning on Persimmon Tree Point at a point 35° 18.3915' N – 76° 29.0454' W; running southerly to Ya

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Hammock Point to a point 35° 17.1825' N – 76° 28.8713' W;

(k) Big Porpoise Bay - northwest of a line beginning on Big Porpoise Point at a point 35° 15.6993' N – 76° 28.2041' W; running southwesterly to Middle Bay Point to a point 35° 14.9276' N – 76° 28.8658' W;

(l) Middle Bay - west of a line beginning on Deep Point at a point 35° 14.8003' N – 76° 29.1923' W; running southerly to Little Fishing Point to a point 35° 13.5419' N – 76° 29.6123' W;

(m) Jones Bay - west of a line beginning on Mink Trap Point at a point 35° 13.4968' N – 76° 31.1040' W; running southerly to Boar Point to a point 35° 12.3253' N – 76° 31.2767' W; and

(n) ~~In~~ in the Bay River Area:

(i) Bonner Bay - southeast of a line beginning on the west shore at a point 35° 09.6281' N – 76° 36.2185' W; running northeasterly to Davis Island Point to a point 35° 10.0888' N – 76° 35.2587' W; and

(ii) Gales Creek-Bear Creek - north and west of a line beginning on Sanders Point at a point 35° 11.2833' N – 76° 35.9000' W; running northeasterly to the east shore to a point 35° 11.9000' N – 76° 34.2833' W;

(3) ~~In~~ in the Pamlico and Pungo Rivers Area:

(a) Pungo River - north of a line beginning on the west shore at a point 35° 32.2000' N – 76° 29.2500' W; running east near Beacon "21" to the east shore to a point 35° 32.0833' N – 76° 28.1500' W;

(b) Pungo Creek - west of a line beginning on Persimmon Tree Point at a point 35° 30.7633' N – 76° 38.2831' W; running southwesterly to Windmill Point to a point 35° 31.1546' N – 76° 37.7590' W;

(c) Scranton Creek - south and east of a line beginning on the west shore at a point 35° 30.6810' N – 76° 28.3435' W; running easterly to the east shore to a point 35° 30.7075' N – 76° 28.6766' W;

(d) Slade Creek - east of a line beginning on the west shore at a point 35° 27.8879' N – 76° 32.9906' W; running southeasterly to the east shore to a point 35° 27.6510' N – 76° 32.7361' W;

~~(b)~~(e) Fortescue Creek - east of a line beginning on Pasture Point at a point 35° 25.9213' N – 76° 31.9135' W; running southerly to the Lupton Point shore to a point 35° 25.6012' N – 76° 31.9641' W;

~~(c)~~(f) Pamlico River - west of a line beginning on Ragged Point at a point 35° 27.5768' N – 76° 54.3612' W; running southwesterly to Mauls Point to a point 35° 26.9176' N – 76° 55.5253' W;

~~(d)~~(g) North Creek - north of a line beginning on the west shore at a point 35° 25.3988' N – 76° 40.0455' W; running southeasterly to the east shore to a point 35° 25.1384' N – 76° 39.6712' W;

(h) South Creek - west of a line beginning on Hickory Point at a point 35° 21.7385' N – 76° 41.5907' W; running southerly to Fork Point to a point 35° 20.7534' N – 76° 41.7870' W;

(i) Bond Creek/Muddy Creek - south of a line beginning on Fork Point at a point 35° 20.7534' N – 76° 41.7870' W; running southeasterly to Gum Point to a point 35° 20.5632' N – 76° 41.4645' W;

~~(e)~~(j) ~~In~~ in the Goose Creek Area, Campbell Creek - west of a line beginning on the north shore at a point 35° 17.3600' N – 76° 37.1096' W; running southerly to the south shore to a point 35° 16.9876' N – 76° 37.0965' W; and

~~(f)~~(k) Oyster Creek-Middle Prong - southwest of a line beginning on Pine Hammock at a point 35° 19.5586' N – 76° 32.8830' W; running easterly to Cedar Island to a point 35° 19.5490' N – 76° 32.7365' W; and southwest of a line beginning on Cedar Island at a point 35° 19.4921' N – 76° 32.2590' W; running southeasterly to Beard Island Point to a point 35° 19.1265' N – 76° 31.7226' W;

(4) ~~In~~ in the Neuse River Area:

(a) Lower Broad Creek - west of a line beginning on the north shore at a point 35° 05.8314' N – 76° 35.3845' W; running southwesterly to the south shore to a point 35° 05.5505' N – 76° 35.7249' W;

(b) Greens Creek - north of a line beginning on the west shore of Greens Creek at a point 35° 01.3476' N – 76° 42.1740' W; running northeasterly to the east shore to a point 35° 01.4899' N – 76° 41.9961' W;

(c) Dawson Creek - north of a line beginning on the west shore at a point 34° 59.5920' N – 76° 45.4620' W; running southeasterly to the east shore to a point 34° 59.5800' N – 76° 45.4140' W;

(d) Goose Creek - north and east of a line beginning at a point on the west shore at a point 35° 02.6642' N – 76° 56.4710' W; running southeasterly to a point on Cooper Point 35° 02.0908' N – 76° 56.0092' W;

(e) Upper Broad Creek - northeast of a line beginning at a point on Rowland Point on the north shore at a point 35° 02.6166' N – 76° 56.4500' W; running southeasterly to the south shore to a point 35° 02.8960' N – 76° 56.7865' W;

(f) Clubfoot Creek - south of a line beginning on the west shore at a point 34° 54.5424' N – 76° 45.7252' W; running easterly to the east shore to a point 34° 54.4853' N – 76° 45.4022' W; and

(g) ~~In~~ in the Adams Creek Area, Cedar Creek - east of a line beginning on the north shore at a point 34° 56.1203' N – 76° 38.7988' W; running southerly to the south shore to a point 34° 55.8745' N – 76° 38.8153' W;

(5) Newport River - west of a line beginning near Penn Point on the south shore at a point 34° 45.6960' N – 76° 43.5180' W; running northeasterly to the north shore to a point 34° 46.8490' N – 76° 43.3296' W;

~~(5)~~(6) Virginia Creek - all waters of the natural channel northwest of the primary nursery area line;

~~(6)~~(7) Old Topsail Creek - all waters of the dredged channel northwest of the primary nursery area line;

~~(7)~~(8) Mill Creek - all waters west of a line beginning on the north shore at a point 34° 20.6420' N – 77° 42.1220' W; running southwesterly to the south shore to a point 34° 20.3360' N – 77° 42.2400' W;

~~(8)~~(9) Pages Creek - all waters west of a line beginning on the north shore at a point 34° 16.1610' N – 77° 45.9930' W; running southwesterly to the south shore to a point 34° 15.9430' N – 77° 46.1670' W;

~~(9)~~(10) Bradley Creek - all waters west of a line beginning on the north shore at a point 34° 12.7030' N – 77° 49.1230' W; running southerly near the dredged channel to a point 34° 12.4130' N – 77° 49.2110' W; ~~and~~

(11) Cape Fear River - all waters bounded by a line beginning on the south side of the Spoil Island at the intersection of the Intracoastal Waterway and the Cape Fear River ship channel at a point 34° 01.5780' N – 77° 56.0010' W; running easterly to the east shore of the Cape Fear River to a point 34° 01.7230' N – 77° 55.1010' W; running southerly and bounded by the shoreline to the Ferry Slip at Federal Point at a point 33° 57.8080' N – 77° 56.4120' W; running northerly to Bird Island to a point 33° 58.3870' N – 77° 56.5780' W; running northerly along the west shoreline of Bird Island and the Cape Fear River spoil islands back to point of origin;

(12) Lockwood Folly River - all waters north of a line beginning on Howells Point at a point 33° 55.3680' N – 78° 12.7930' W and running in a westerly direction along the Intracoastal Waterway near Intracoastal Waterway Marker "46" to a point 33° 55.3650' N – 78° 13.8500' W;

(13) Saucepan Creek - all waters north of a line beginning on the west shore at a point 33° 54.6290' N – 78° 22.9170' W; running northeasterly to the east shore to a point 33° 54.6550' N – 78° 22.8670' W; and

~~(10)~~(14) Davis Creek - all waters east of a line beginning on Horse Island at a point 33° 55.0160' N – 78° 12.7380' W; running southerly to Oak Island to a point 33° 54.9190' N – 78° 12.7170' W; continuing upstream to the primary nursery line and Davis Canal, all waters southeast of a line beginning on Pinner Point at a point 33° 55.2930' N – 78° 11.6390' W; running southwesterly across the mouth of Davis Canal to the spoil island at the southwest intersection of the ~~IWW~~ Intracoastal Waterway and Davis Canal to a point 33° 55.2690' N – 78° 11.6550' W.

Authority G.S. 113-134; 113-182; 143B-289.52.

15A NCAC 03R .0105 SPECIAL SECONDARY NURSERY AREAS

The special secondary nursery areas referenced in 15A NCAC 03N .0105(b) are designated in the following coastal water areas:

(1) Roanoke Sound:

(a) Outer Shallowbag Bay - west of a line beginning on Baum Point at a point 35° 55.1461' N – 75° 39.5618' W; running southeasterly to Ballast Point to a point 35° 54.6250' N – 75° 38.8656' W; including the canal on the southeast shore of Shallowbag Bay; and

(b) Kitty Hawk Bay/Buzzard Bay - within the area designated by a line beginning at a point on the east shore of ~~Collington~~ Colington Creek at a point 36° 02.4360' N – 75° 42.3189' W; running westerly to a point

02.6630' N – 75° 41.4102' W; running along the shoreline to a point 36° 02.3264' N – 75° 42.3889' W; running southwesterly to a point 36° 02.1483' N – 75° 42.4329' W; running along the shoreline to a point 36° 01.6736' N – 75° 42.5313' W; running southwesterly to a point 36° 01.5704' N – 75° 42.5899' W; running along the shoreline to a point 36° 00.9162' N – 75° 42.2035' W; running southeasterly to a point 36° 00.8253' N – 75° 42.0886' W; running along the shoreline to a point 35° 59.9886' N – 75° 41.7284' W; running southwesterly to a point 35° 59.9597' N – 75° 41.7682' W; running along the shoreline to the mouth of Buzzard Bay to a point 35° 59.6480' N – 75° 32.9906' W; running easterly to Mann Point to a point 35° 59.4171' N – 75° 32.7361' W; running northerly along the shoreline to the point of beginning;

~~(2) In the Pamlico and Pungo rivers Area:~~

~~(a) Pungo Creek - west of a line beginning on Persimmon Tree Point at a point 35° 30.7633' N – 76° 38.2831' W; running southwesterly to Windmill Point to a point 35° 31.1546' N – 76° 37.7590' W;~~

~~(b) Scranton Creek – south and east of a line beginning on the west shore at a point 35° 30.6810' N – 76° 28.3435' W; running easterly to the east shore to a point 35° 30.7075' N – 76° 28.6766' W;~~

~~(c) Slade Creek – east of a line beginning on the west shore at a point 35° 27.8879' N – 76° 32.9906' W; running southeasterly to the east shore to a point 35° 27.6510' N – 76° 32.7361' W;~~

~~(d) South Creek - west of a line beginning on Hickory Point at a point 35° 21.7385' N – 76° 41.5907' W; running southerly to Fork Point to a point 35° 20.7534' N – 76° 41.7870' W; and~~

~~(e) Bond Creek/Muddy Creek – south of a line beginning on Fork Point 35° 20.7534' N – 76° 41.7870' W; running southeasterly to Gum Point to a point 35° 20.5632' N – 76° 41.4645' W;~~

~~(3)~~(2) ~~In~~ in the West Bay Area:

(a) West Thorofare Bay - south of a line beginning on the west shore at a point 34° 57.2199' N – 76° 24.0947' W; running easterly to the east shore to a point 34° 57.4871' N – 76° 23.0737' W;

(b) Long Bay-Ditch Bay - west of a line beginning on the north shore of Ditch Bay at a point 34° 57.9388' N – 76° 27.0781' W; running southwesterly to the south shore of Ditch Bay to a point 34° 57.2120' N – 76° 27.2185' W; then south of a line running southeasterly to the east shore of Long Bay to a point 34° 56.7633' N – 76° 26.3927' W; and

(c) Turnagain Bay - south of a line beginning on the west shore at a point 34° 59.4065' N – 76° 30.1906' W; running easterly to the east shore to a point 34° 59.5668' N – 76° 29.3557' W;

~~(4)~~(3) ~~In~~ in the Core Sound Area:

(a) Cedar Island Bay - northwest of a line beginning near the gun club dock at a point 34° 58.7203' N – 76° 15.9645' W; running northeasterly to the south shore to a point 34° 57.7690' N – 76° 16.8781' W;

(b) Thorofare Bay-Barry Bay - northwest of a line beginning on Rumley Hammock at a point 34° 55.4853' N – 76° 18.2487' W; running northeasterly to Hall Point to a point 34° 54.4227' N – 76° 19.1908' W;

(c) Nelson Bay - northwest of a line beginning on the west shore of Nelson Bay at a point 34° 51.1353' N – 76° 24.5866' W; running northeasterly to Drum Point to a point 34° 51.6417' N – 76° 23.7620' W;

(d) Brett Bay - north of a line beginning on the west shore at a point 34° 49.4019' N – 76° 26.0227' W; running easterly to Piney Point to a point 34° 49.5799' N – 76° 25.0534' W; and

(e) Jarrett Bay - north of a line beginning on the west shore near Old Chimney at a point 34° 45.5743' N – 76° 30.0076' W; running easterly to a point east of Davis Island 34° 45.8325' N – 76° 28.7955' W;

~~(5)~~(4) ~~In~~ in the North River Area:

(a) North River - north of a line beginning on the west shore at a point 34° 46.0383' N – 76° 37.0633' W; running easterly to a point on the east shore 34° 46.2667' N – 76° 35.4933' W; and

(b) Ward Creek - east of a line beginning on the north shore at a point 34° 46.2667' N – 76° 35.4933' W; running southerly to the south shore to a point 34° 45.4517' N – 76° 35.1767' W;

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~~(6)~~ ~~Newport River - west of a line beginning near Penn Point on the south shore at a point 34° 45.6960' N – 76° 43.5180' W; running northeasterly to the north shore to a point 34° 46.8490' N – 76° 43.3296' W;~~

~~(7)~~<u>(5)</u> New River - all waters upstream of a line beginning on the north side of the N.C. Highway 172 Bridge at a point 34° 34.7680' N – 77° 23.9940' W; running southerly to the south side of the bridge at a point 34° 34.6000' N – 77° 23.9710' W;

~~(8)~~<u>(6)</u> Chadwick Bay - all waters west of a line beginning on the northeast side of Chadwick Bay at a point 34° 32.5630' N – 77° 21.6280' W; running southeasterly to a point near Marker "6" at 34° 32.4180' N – 77° 21.6080' W; running westerly to Roses Point at a point 34° 32.2240' N – 77° 22.2880' W; following the shoreline in Fullard Creek to a point 34° 32.0340' N – 77° 22.7160' W; running northwesterly to a point 34° 32.2210' N – 77° 22.8080' W; following the shoreline to the west point of Bump's Creek at a point 34° 32.3430' N – 77° 22.4570' W; running northeasterly to the east shore to a point 34° 32.4400' N – 77° 22.3830' W; following the shoreline of Chadwick Bay back to the point of origin; <u>and</u>

~~(9)~~<u>(7)</u> Intracoastal Waterway - all waters in the ~~IWW~~ <u>Intracoastal Waterway</u> maintained channel from a point near Marker "17" north of Alligator Bay 34° 30.7930' N – 77° 23.1290' W; to a point near Marker "49" at Morris Landing at a point 34° 28.0820' N – 77° 30.4710' W; and all waters in the ~~IWW~~ <u>Intracoastal Waterway</u> maintained channel and 100 feet on either side from Marker "49" to the N.C. Highway 50-210 Bridge at Surf ~~City;~~ <u>City.</u>

~~(10)~~ ~~Cape Fear River - all waters bounded by a line beginning on the south side of the Spoil Island at the intersection of the IWW and the Cape Fear River ship channel at a point 34° 01.5780' N – 77° 56.0010' W; running easterly to the east shore of the Cape Fear River to a point 34° 01.7230' N – 77° 55.1010' W; running southerly and bounded by the shoreline to the Ferry Slip at Federal Point at a point 33° 57.8080' N – 77° 56.4120' W; running northerly to Bird Island to a point 33° 58.3870' N – 77° 56.5780' W; running northerly along the west shoreline of Bird Island and the Cape Fear River spoil islands back to point of origin;~~

~~(11)~~ ~~Lockwood Folly River - all waters north of a line beginning on Howells Point at a point 33° 55.3680' N – 78° 12.7930' W and running in a westerly direction along the IWW near IWW Marker "46" to a point 33° 55.3650' N – 78° 13.8500' W; and~~

~~(12)~~ ~~Saucepan Creek - all waters north of a line beginning on the west shore at a point 33° 54.6290' N – 78° 22.9170' W; running northeasterly to the east shore to a point 33° 54.6550' N – 78° 22.8670' W.~~

Authority G.S. 113-134; 113-182; 143B-289.52.

15A NCAC 03R .0117 OYSTER SANCTUARIES

The Oyster Sanctuaries referenced in 15A NCAC 03K .0209 are delineated in the following coastal water areas:

~~(1)~~ ~~Croatan Sound area: within the area described by a line beginning at a point 35° 48.2842' N - 75° 38.3360' W; running southerly to a point 35° 48.1918' N - 75° 38.3360' W; running westerly to a point 35° 48.1918' N - 75° 38.4575' W; running northerly to a point 35° 48.2842' N - 75° 38.4575' W; running easterly to the point of beginning.~~

~~(2)~~<u>(1)</u> Pamlico Sound area:

<u>(a)</u> <u>Croatan Sound: within the area described by a line beginning at a point 35° 48.2842' N - 75° 38.3360' W; running southerly to a point 35° 48.1918' N - 75° 38.3360' W; running westerly to a point 35° 48.1918' N - 75° 38.4575' W; running northerly to a point 35° 48.2842' N - 75° 38.4575' W; running easterly to the point of beginning.</u>

~~(a)~~<u>(b)</u> Crab Hole: within the area described by a line beginning at a point 35° 43.6833' N - 75° 40.5083' W; running southerly to a point 35° 43.5000' N - 75° 40.5083' W; running westerly to a point 35° 43.5000' N - 75° 40.7500' W; running northerly to a point 35° 43.6833' N - 75° 40.7500' W; running easterly to the point of beginning.

<u>(c)</u> <u>Pea Island: within the area described by a line beginning at a point 35° 05.4760' N - 76° 23.5370' W; running southerly to a point 35° 05.4760' N - 76° 23.4040' W; running westerly to a point 35° 05.3680' N - 76° 23.4040' W; running northerly to a point 35° 05.3680' N - 76° 23.5370' W; running easterly to the point of beginning.</u>

<u>(d)</u> <u>Long Shoal: within the area described by a line beginning at a point 35° 33.8600' N - 75° 49.9000' W; running southerly to a point 35° 33.8600' N - 75° 49.7670' W; running westerly to a point 35° 33.7510' N - 75° 49.7670' W; running northerly to a point 35° 33.7510' N - 75° 49.9000' W; running easterly to the point of beginning.</u>

~~(b)~~<u>(e)</u> Gibbs Shoal: within the area desc[ribed] by a line beginning at a poin[t]

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~~27.3557' N - 75° 55.8434' W;~~ 35° 27.3550' N - 75° 55.9190' W; running southerly to a point ~~35° 27.1732' N - 75° 55.8434' W;~~ 35° 27.1010' N - 75° 55.9190' W; running westerly to a point ~~35° 27.1732' N - 75° 56.0735' W;~~ 35° 27.1010' N - 75° 56.2300' W; running northerly to a point ~~35° 27.3557' N - 75° 56.0735' W;~~ 35° 27.3550' N - 75° 56.2300' W; running easterly to the point of beginning.

~~(c)~~(f) Deep Bay: within the area described by a line beginning at a point 35° 22.9126' N - 76° 22.1612' W; running southerly to a point 35° 22.7717' N - 76° 22.1612' W; running westerly to a point 35° 22.7717' N - 76° 22.3377' W; running northerly to a point 35° 22.9126' N - 76° 22.3377' W; running easterly to the point of beginning.

~~(d)~~(g) West Bluff: within the area described by a line beginning at a point ~~35° 18.3000' N - 76° 10.0890' W;~~ 35° 18.3160' N - 76° 10.2960' W; running southerly to a point ~~35° 18.1460' N 76° 10.0890' W;~~ 35° 18.3160' N - 76° 10.0690' W; running westerly to a point ~~35° 18.1460' N - 76° 10.2760' W;~~ 35° 18.1290' N - 76° 10.0690' W; running northerly to a point ~~35° 18.3000' N - 76° 10.2760' W;~~ 35° 18.1290' N - 76° 10.2960' W; running easterly to the point of beginning.

~~(e) Clam Shoal: within the area described by a line beginning at a point 35° 17.4800' N - 75° 37.1800' W; running southerly to a point 35° 17.1873' N - 75° 37.1800' W; running westerly to a point 35° 17.1873' N - 75° 37.4680' W; running northerly to a point 35° 17.4800' N - 75° 37.4680' W; running easterly to the point of beginning.~~

~~(f)~~(h) Middle Bay: within the area described by a line beginning at a point 35° 14.1580' N - 76° 30.1780' W; running southerly to a point 35° 14.1150' N - 76° 30.1780' W; running westerly to a point 35° 14.1150' N - 76° 30.3320' W; running northerly to a point 35° 14.1580' N - 76° 30.3320' W; running easterly to the point of beginning.

(i) Swan Island: within the area described by a line beginning at a point 35° 05.6170' N - 76° 27.5040' W; running southerly to a point 35° 05.6020' N - 76° 26.7650' W; running westerly to a point 35° 05.4850' N - 76° 26.7640' W; running northerly to a point 35° 05.4990' N - 76° 27.5030' W; running easterly to the point of beginning.

~~(g) Ocracoke area: within the area described by a line beginning at a point 35° 10.8150' N - 75° 59.6320' W; running southerly to a point 35° 10.6320' N - 75° 59.6320' W; running westerly to a point 35° 10.6320' N - 75° 59.8530' W; running northerly to a point 35° 10.8150' N - 75° 59.8530' W; running easterly to the point of beginning.~~

(j) Raccoon Island: within the area described by a line beginning at a point 35° 05.4760' N - 76° 23.5370' W; running southerly to a point 35° 05.4760' N - 76° 23.4040' W; running westerly to a point 35° 05.3860' N - 76° 23.4040' W; running northerly to a point 35° 05.3680' N - 76° 23.5370' W; running easterly to the point of beginning.

~~(h)~~(k) West Bay: within the area described by a line beginning at a point 34° 58.8517' N - 76° 21.3632' W; running southerly to a point 34° 58.7661' N - 76° 21.3632' W; running westerly to a point 34° 58.7661' N - 76° 21.4735' W; running northerly to a point 34° 58.8517' N - 76° 21.4735' W; running easterly to the point of beginning.

~~(3)~~(2) Neuse ~~River:~~ River area:

(a) Little Creek: within the area described by a line beginning at a point 35° 02.6940' N - 76° 30.9840' W; running southerly to a point 35° 02.6940' N - 76° 30.7940' W; running westerly to a point 35° 02.5380' N - 76° 30.7940' W; running northerly to a point 35° 02.5380' N - 76° 30.9840' W; running easterly to the point of beginning.

(b) Neuse River: within the area described by a line beginning at a point ~~35° 00.4742' N - 76° 31.9550' W;~~ 35° 00.4910' N - 76° 31.9350' W; running southerly to a point ~~35° 00.3920' N - 76° 31.9550' W;~~ 35° 00.3750' N - 76° 31.9350' W; running westerly to a point ~~35° 00.3920' N - 76° 32.0550' W;~~ 35° 00.3750' N - 76° 32.0750' W; running northerly to a point ~~35° 00.4742' N - 76° 32.0550' W;~~ 35° 00.4910' N - 76° 32.0750' W; running easterly to the point of beginning

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Authority G.S. 113-134; 113-182; 113-201; 113-204; 143B-289.52.

SUBCHAPTER 18A – SANITATION

SECTION .0100 - HANDLING: PACKING: AND SHIPPING OF CRUSTACEA MEAT

15A NCAC 18A .0140 FLOORS
Floors shall be of concrete or other equally impervious material, constructed so that they may be easily cleaned and shall be sloped so that water drains.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0141 WALLS AND CEILINGS
(a) Walls and ceilings shall be constructed of smooth, easily cleanable, non-corrosive, impervious material.
(b) Insulation on cooked crustacea cooler walls shall be covered to the ceiling with a smooth, easily cleanable, non-corrosive, impervious material.
(c) Doors and windows shall be properly fitted and maintained in good repair.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0142 LIGHTING
(a) Natural or artificial lighting shall be provided in all parts of the facility. Minimum lighting intensities shall be as follows:
(1) 50 foot-candles on working surfaces in the picking and packing rooms and areas.
(2) 10 foot-candles measured at a height of 30 inches above the floor throughout the rest of the processing portion of the facility.
(b) Light bulbs within the processing portion of the facility shall be shatterproof or shielded to prevent product contamination in case of breakage.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0143 VENTILATION
All rooms and areas shall be ventilated.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0146 PREMISES
(a) Premises under the control of the owner shall be kept clean at all times. Waste materials, rubbish, other ~~articles~~ articles, or litter shall not be permitted to accumulate on the premises. Other items shall be properly stored.
(b) Measures shall be taken to prevent the harborage and breeding of insects, ~~rodents~~ rodents, and other vermin on premises.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0150 SEWAGE DISPOSAL
All sewage and other liquid wastes shall be disposed of in a public sewer system or in the absence of a public sewer system, by an on-site method approved by the Division of Marine Fisheries or the Department of ~~Environment, Health, and Natural Resources.~~ Environmental Quality.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0154 EMPLOYEES' PERSONAL ARTICLES
Employees' street clothing, aprons, ~~gloves~~ gloves, and personal articles shall not be stored in rooms or areas described in Rule .0159(b) of this Section.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0155 SUPPLY STORAGE
Shipping containers, ~~boxes~~ boxes, and other supplies shall be stored in a storage room or area. The storage room or area shall be kept clean.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0159 SEPARATION OF OPERATIONS
(a) Facility design shall provide for continuous flow of raw materials and product to prevent contamination by exposure to areas involved in earlier processing steps, ~~refuse~~ refuse, or other areas subject to contamination.
(b) The following processes shall be carried out in separate rooms or areas:
(1) ~~Raw~~ raw crustacea receiving or ~~refrigeration.~~ refrigeration;
(2) ~~Crustacea cooking.~~ crustacea cooking;
(3) ~~Cooked~~ cooked crustacea ~~air-cool.~~ air-cool;
(4) ~~Cooked~~ cooked crustacea ~~refrigeration.~~ refrigeration;
(5) ~~Picking.~~ picking;
(6) ~~Packing.~~ packing;
(7) ~~Picked~~ picked crustacea meat ~~refrigeration.~~ refrigeration;
(8) ~~Pasteurizing/thermal processing.~~ pasteurizing or thermal processing;
(9) ~~Machine picking.~~ machine picking;
(10) ~~Repacking.~~ repacking; and
(11) ~~Other~~ other processes when carried out in conjunction with the cooking of crustacea or crustacea meat.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0160 RAW CRUSTACEA RECEIVING AND REFRIGERATION
(a) Only fresh crustacea shall be accepted for processing.

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(b) Within two hours of receipt at the facility, crustacea shall be cooked or placed in a refrigerated area maintaining a temperature of 50° F (~~10~~ (10° C) or below.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0163 COOKED CRUSTACEA REFRIGERATION

(a) The cooked crustacea cooler shall be large enough to store all cooked crustacea and maintain a minimum temperature of 40° F (4.4° C). The cooler shall open directly into the picking room or into a clean, enclosed area leading into the picking room.
(b) Cooked crustacea shall be stored at a temperature between 33° F (0.5° C) and 40° F (4.4° C) ambient air temperature if not immediately processed. The cooler shall be equipped with an accurate, operating thermometer.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0167 DELIVERY WINDOW OR SHELF

A delivery window or a non-corrosive shelf shall be provided between the picking room and packing room or area. The delivery window shall be equipped with a shelf completely covered with smooth, non-corrosive metal or other material approved by the Division of Marine Fisheries and sloped to drain towards the picking room.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0169 FREEZING

(a) If crustacea or crustacea meat is to be frozen, the code date shall be followed by the letter "F."
(b) Frozen crustacea or crustacea meat shall be stored at a temperature of 0° F (-18° C) or less.
(c) The frozen storage rooms shall be equipped with an accurate, operating thermometer.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0170 SHIPPING

Cooked crustacea and crustacea meat shall be shipped between 33° F (0.5° C) and 40° F (4.4° C). Frozen crustacea products shall be shipped at 0° F (-18° C) or below.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0171 WHOLE CRUSTACEA OR CRUSTACEA PRODUCTS

Whole crustacea, ~~claws~~ claws, or any other crustacea products shall be prepared, ~~packaged~~ packaged, and labeled in accordance with the rules of this Section.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0172 COOKED CLAW SHIPPING CONDITIONS

(a) Vehicles used to transport cooked claws shall be mechanically refrigerated, enclosed, tightly constructed, kept ~~clean~~ clean, and equipped with an operating thermometer.
(b) Cooked crab claws shall be stored and transported between 33° F (0.5° C) and 40° F (4.4° C) ambient air temperature.
(c) All vehicles shall be approved by the Division of Marine Fisheries prior to use.
(d) Cooked claw shipping containers shall be marked for intended use, ~~cleaned~~ cleaned, and sanitized prior to use and approved by the Division.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0179 RECALL PROCEDURE

Each owner of a cooked crustacea or crustacea meat facility or repacker facility shall keep on file a written product recall procedure. A copy of this recall procedure shall be provided to the ~~Division.~~ Division of Marine Fisheries.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0180 SAMPLING AND TESTING

Samples of cooked crustacea or crustacea meat may be taken and examined by the Division of Marine Fisheries at any time or place. Samples of cooked crustacea or crustacea meat shall be furnished by the owner or operator of facilities, trucks, carriers, stores, ~~restaurants~~ restaurants, and other places where cooked crustacea or crustacea meat are sold.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0188 HAZARD ANALYSIS

Each dealer shall conduct a hazard analysis to determine the food safety hazards that are reasonably likely to occur for each kind of crustacea or crustacea meat product processed by that dealer and to identify the preventative measures that the dealer can apply to control those hazards.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0189 HACCP PLAN

Each dealer shall have and implement a written ~~HACCP~~ Hazard Analysis and Critical Control Points (HACCP) Plan. The owner or authorized designee shall sign the plan when implemented and after any modification. The plan shall be reviewed and updated, if necessary, at least annually. The plan shall, at a minimum:

(1) ~~List~~ list the food safety hazards that are reasonably likely to occur;
(2) ~~List~~ list the critical control points for each of the food safety hazards;

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(3) ~~List~~ list the critical limits that must be met for each of the critical control points;
(4) ~~List~~ list the procedures, and frequency thereof, that will be used to monitor each of the critical control points to ensure compliance with the critical limits;
(5) ~~List~~ list any corrective action plans to be followed in response to deviations from critical limits at critical control points;
(6) ~~Provide~~ provide a record keeping system that documents critical control point monitoring; and
(7) ~~List~~ list the verification procedures, and frequency thereof, that the dealer will use.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0190 SANITATION MONITORING REQUIREMENTS

Each dealer shall monitor, at a minimum, the following sanitation items:

(1) ~~Safety~~ safety of water;
(2) ~~Condition~~ condition and cleanliness of food contact surfaces;
(3) ~~Prevention~~ prevention of cross contamination;
(4) ~~Maintenance~~ maintenance of hand washing, hand ~~sanitizing~~ sanitizing, and toilet facilities;
(5) ~~Protection~~ protection of crustacea or crustacea meat, crustacea or crustacea meat packaging ~~materials~~ materials, and food contact surfaces from adulteration;
(6) ~~Proper~~ proper labeling, ~~storage~~ storage, and use of toxic compounds;
(7) ~~Control~~ control of employees with adverse health conditions; and
(8) ~~Exclusion~~ exclusion of pests from the facility.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

SECTION .0400 - SANITATION OF SHELLFISH - GENERAL OPERATION STANDARDS

15A NCAC 18A .0431 STANDARDS FOR AN APPROVED SHELLFISH GROWING AREA

~~In order that an area be approved for shellfish harvesting for direct market purposes the following criteria must be satisfied as indicated by sanitary survey:~~

~~(1) the shoreline survey has indicated that there is no significant point source contamination;~~
~~(2) the area is not so contaminated with fecal material that consumption of the shellfish might be hazardous;~~
~~(3) the area is not so contaminated with radionuclides or industrial wastes that consumption of the shellfish might be hazardous; and~~
~~(4) the median fecal coliform Most Probable Number (MPN) or the geometric mean MPN of water shall not exceed 14 per 100 milliliters, and not more than 10 percent of the samples shall exceed a fecal coliform MPN of 43 per 100 milliliters (per five tube decimal dilution) in those portions of areas most probably exposed to fecal contamination during most unfavorable hydrographic conditions.~~

Authority G.S. 130A-230.

SECTION .0700 - OPERATION OF DEPURATION (MECHANICAL PURIFICATION) FACILITIES

15A NCAC 18A .0704 LABORATORY PROCEDURES

(a) ~~The laboratory and the laboratory operator shall be approved by the Division.~~ All laboratory analyses used to evaluate the effectiveness of the depuration process shall be performed by a laboratory found to conform or provisionally conform to the requirements established under the National Shellfish Sanitation Program (NSSP), as determined by a Food and Drug Administration (FDA) Shellfish Laboratory Evaluation Officer or by an FDA certified State Shellfish Laboratory Evaluation Officer.

~~(b) The laboratory shall conduct routine bacterial examinations of process water and shellfish, and special examinations when necessary or required in accordance with Rule. 0706 of this Subchapter.~~

~~(c)~~(b) ~~Bacterial examinations of shellfish and sea water shall be made in accordance with "Recommended Procedures for Examination of Sea Water and Shellfish", American Public Health Association, Inc., which is adopted by reference in accordance with G.S. 150B-14(c), or other methods approved by the Division. A copy of this publication is available for inspection at the Shellfish Sanitation Office, Marine Fisheries Building, Arendell Street, Morehead City, North Carolina 28557.~~ All methods for the analysis of depuration process water and shellfish that are used to evaluate the effectiveness of the depuration process shall be cited in the latest approved edition of the NSSP Guide for the Control of Molluscan Shellfish, Section IV: Guidance Documents, subsection Approved NSSP Laboratory Tests or validated for use by the NSSP under the Constitution, Bylaws and Procedures of the Interstate Shellfish Sanitation Conference. If there is an immediate or ongoing critical need for a method and no method approved for use within the NSSP exists, the following may be used:

(1) a validated Association of Analytical Communities, Bacteriological Analysis Manual, or Environmental Protection Agency method; or
(2) an Emergency Use Method as set forth in the latest approved edition of the NSSP Guide for the Control of Molluscan Shellfish.

(c) The laboratory shall conduct examinations of depuration process water and shellfish and conduct special examinations if necessary or required, in accordance with Rules .0706 through .0709 of this Section.

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~~(d) All other physical, chemical, or biological tests shall be conducted according to "Standard Methods for the Examination of Water and Waste Water", prepared and published by American Public Health Association, American Water Works Association, and Water Pollution Control Federation, which is adopted by reference in accordance with G.S. 150B-14(c), or other methods approved by the Division. A copy of this publication is available for inspection at the Shellfish Sanitation Office, Fisheries Building, Arendell Street, Morehead City, North Carolina 28557.~~

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

SECTION .0900 - CLASSIFICATION OF SHELLFISH GROWING WATERS

15A NCAC 18A .0901 DEFINITIONS

The following definitions shall apply throughout this Section.

(1) ~~"Approved area"~~ "Approved" means ~~an area~~ shellfish growing waters determined suitable for the harvesting of shellfish for direct market purposes.

(2) "Closed-system marina" means a marina constructed in canals, basins, tributaries or any other area with restricted tidal flow.

(3) "Colony forming unit" means an estimate of the number of viable bacteria cells in a sample as determined by a plate count.

~~(3)~~(4) "Commercial marina" means ~~marinas~~ a marina that ~~offer~~ offers one or more of the following services: fuel, transient dockage, haul-out facilities, or repair services.

~~(4)~~(5) "Conditionally ~~approved area"~~ approved" means ~~an area~~ shellfish growing waters that are subject to predictable intermittent pollution but that may be used for harvesting shellfish for direct market purposes when management plan criteria are met.

~~(5) "Depuration" means mechanical purification or the removal of adulteration from live shellstock by any artificially controlled method.~~

(6) "Division" means the Division of ~~Environmental Health~~ Marine Fisheries or its authorized agent.

(7) "Estimated 90th percentile" means a statistic that measures the variability in a sample set that shall be calculated by:

(a) calculating the arithmetic mean and standard deviation of the sample result logarithms (base 10);

(b) multiplying the standard deviation in Sub-Item (a) of this Item by 1.28;

(c) adding the product from Sub-Item (b) of this Item to the arithmetic mean; and

(d) taking the antilog (base 10) of the results from Sub-Item (c) of this Item to determine the estimated 90th percentile.

~~(7)~~(8) "Fecal coliform" means bacteria of the coliform group ~~which~~ that will produce gas from lactose in a multiple tube procedure liquid medium (EC or A-1) within 24 plus or minus two hours at 44.5°C plus or minus 0.2°C in a water bath.

(9) "Geometric mean" means the antilog (base 10) of the arithmetic mean of the sample result logarithm.

~~(8) "Growing waters" means waters which support or could support shellfish life.~~

~~(9)~~(10) "Marina" means any water area with a structure (dock, basin, floating dock, etc.) ~~which~~ that is utilized for docking or otherwise mooring vessels and constructed to provide temporary or permanent docking space for more than 10 boats.

~~(10)~~(11) "Marine biotoxins" means ~~a poisonous substance accumulated by shellfish feeding upon dinoflagellates containing toxins.~~ any poisonous compound produced by marine microorganisms and accumulated by shellstock.

(12) "Median" means the middle number in a given sequence of numbers, taken as the average of the two middle numbers when the sequence has an even number of numbers.

~~(11)~~(13) "Most probable number (MPN)" means a statistical estimate of the number of bacteria per unit volume and is determined from the number of positive results in a series of fermentation tubes.

(14) "National Shellfish Sanitation Program (NSSP)" means the cooperative federal-state-industry program for the sanitary control of shellfish that is adequate to ensure that the shellfish produced in accordance with the NSSP Guide For The Control Of Molluscan Shellfish will be safe and sanitary.

~~(12)~~(15) "Open-system marina" means a marina constructed in an area where tidal currents have not been impeded by natural or man-made barriers.

~~(13)~~(16) "Private marina" means any marina that is not a commercial marina as defined in this Rule.

~~(14)~~(17) ~~"Prohibited area"~~ "Prohibited" means ~~an area~~ shellfish growing waters unsuitable for the harvesting of shellfish for direct market purposes.

~~(15)~~(18) "Public health emergency" means any condition that may immediately cause shellfish waters to be unsafe for the harvest of shellfish for human consumption.

~~(16) "Relaying" means the act of removing shellfish from one growing area or shellfish grounds to another area or ground for any purpose.~~

~~(17)~~(19) ~~"Restricted area"~~ "Restricted" means ~~an area~~ shellfish growing waters from which shellfish may be harvested only by permit and are subjected to ~~an approved depuration proc~~

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~~relayed to an approved area.~~ a suitable and effective treatment process through relaying or depuration.

~~(18)~~(20) "Sanitary survey" means the written evaluation of factors that affect the sanitary quality of a shellfish growing area including sources of pollution, the effects of wind, tides and currents in the distribution and dilution of polluting materials, and the bacteriological quality of water.

~~(19)~~(21) "Shellfish" means ~~oysters, mussels, scallops and all varieties of clams. However~~ "shellfish" as defined in G.S. 113-229, except the term shall not include scallops when the final product is the shucked adductor muscle only.

(22) "Shellfish growing area" means a management unit that defines the boundaries of a sanitary survey and that is used to track the location where shellfish are harvested.

(23) "Shellfish growing waters" means marine or estuarine waters that support or could support shellfish life.

(24) "Shellstock" means live molluscan shellfish in the shell.

~~(20)~~(25) "Shoreline survey" means ~~a visual inspection of the environmental factors that affect the sanitary quality of a growing area and identifies sources of pollution when possible.~~ an in-field inspection to identify and evaluate any potential or actual pollution sources or other environmental factors that may impact the sanitary quality of a shellfish growing area.

(26) "Systematic random sampling strategy" means a sampling strategy designed to assess the bacteriological water quality of shellfish growing waters impacted by non-point sources of pollution and scheduled sufficiently far in advance to support random collection with respect to environmental conditions.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0902 CLASSIFICATION OF SHELLFISH GROWING WATERS

(a) All ~~actual and potential~~ shellfish growing ~~areas~~ waters shall be classified by the Division of Marine Fisheries as to their suitability for shellfish harvesting. ~~Growing~~ Shellfish growing waters shall be designated with one of the following classifications:

(1) ~~Approved area,~~ approved;

(2) ~~Conditionally approved area,~~ conditionally approved;

(3) ~~Restricted area,~~ restricted; or

(4) ~~Prohibited area.~~ prohibited.

(b) Maps showing the ~~boundaries and~~ classification of shellfish growing ~~areas~~ waters shall be maintained by the Division.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0903 SANITARY SURVEY

(a) ~~Growing~~ Shellfish growing waters shall be divided into growing areas by the ~~Division.~~ Division of Marine Fisheries. Maps showing the boundaries of these shellfish growing areas shall be maintained by the Division and can be found at: http://portal.ncdenr.org/web/mf/shellfish-closure-maps.

(b) Except in shellfish growing areas where all shellfish growing waters are classified as prohibited, the Division shall complete a ~~A~~ sanitary survey report ~~shall be conducted~~ for each shellfish growing area at least once every three ~~years~~ years. ~~except growing areas that are totally prohibited, and~~

(c) A sanitary survey report shall include the following:

(1) ~~A~~ a shoreline survey. ~~survey to evaluate pollution sources that may affect the area.~~

(2) ~~A hydrographic survey to evaluate meteorological and hydrographic~~ an evaluation of meteorological, hydrodynamic, and geographic factors that may affect distribution of pollutants.

(3) a ~~bacteriological~~ microbiological survey to assess water quality. A ~~bacteriological~~ microbiological survey shall include the collection of ~~growing area~~ water samples and their analysis for fecal coliforms. The number and location of sampling stations shall be selected to produce the data necessary to effectively evaluate all point and non-point pollution ~~sources.~~ sources identified during the shoreline survey. A minimum of ~~15~~ six samples shall be collected annually from each designated sampling station. ~~sets of samples shall be collected from growing areas during the three year evaluation period. Areas without a shoreline may be sampled less frequently.~~

(4) a determination of the appropriate classification for all shellfish growing waters within the shellfish growing area in accordance with Rule .0902 of this Section.

(d) A written sanitary survey report shall be required to designate any portion of a shellfish growing area with a classification other than prohibited, or for a reclassification from:

(1) prohibited to any other classification;

(2) restricted to conditionally approved or approved; or

(3) conditionally approved to approved.

All other reclassifications may be made without a sanitary survey.

(e) In each calendar year that a shellfish growing area is not evaluated with a sanitary survey, a written annual evaluation report shall be completed by the Division and shall include the following:

(1) a microbiological survey to assess water quality as set forth in Subparagraph (c)(3) of this Rule.

(2) an evaluation of changes in pollution source impacts that may affect the classifications of the shellfish growing area.

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If the annual evaluation determines conditions have changed and a classification for shellfish growing waters is incorrect, the Division shall initiate action to reclassify the shellfish growing waters in accordance with Rule .0902 of this Section.
~~(c) Sanitary survey reports shall be prepared every three years.~~
~~(d)~~(f) ~~All sanitary~~ Sanitary survey reports and annual evaluation reports shall be maintained by the Division.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0904 APPROVED ~~AREAS~~ WATERS

~~An area~~ Shellfish growing waters classified as approved for shellfish harvesting ~~for direct market purposes, must satisfy~~ shall meet the following criteria as indicated by a sanitary ~~survey:~~ survey, as set forth in Rule .0903 of this Section:

(1) the shoreline survey ~~has indicated that there is no significant point source contamination;~~ indicates there are no significant point sources of pollution;

(2) the area is not contaminated with fecal material, pathogenic microorganisms, poisonous ~~and~~ or deleterious substances, or marine biotoxins that may render consumption of the shellfish hazardous; and

~~(3) the median fecal coliform Most Probable Number (MPN) or the geometric mean MPN of water shall not exceed 14 per 100 milliliters, and not more than ten percent of the samples shall exceed a fecal coliform MPN of 43 per 100 milliliters (per five tube decimal dilution) in those portions of areas most probably exposed to fecal contamination during adverse pollution conditions.~~

(3) the microbiological survey, as set forth in Rule .0903 (b)(3) of this Section, indicates the bacteriological water quality does not exceed the following standards based on results generated using the systematic random sampling strategy:

(a) a median fecal coliform most probable number (MPN) or geometric mean MPN of 14 per 100 milliliters;

(b) a median fecal coliform colony-forming units (CFU) or geometric mean CFU of 14 per 100 milliliters;

(c) an estimated 90th percentile of 43 MPN per 100 milliliters for a five-tube decimal dilution test; or

(d) an estimated 90th percentile of 31 CFU per 100 milliliters for a membrane filter membrane-Thermotolerant Escherichia coli (mTEC) test.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0905 CONDITIONALLY APPROVED ~~AREAS~~ WATERS

(a) ~~An area~~ Shellfish growing waters may be classified as conditionally approved if the Division of Marine Fisheries determines the following:

(1) the sanitary survey indicates the ~~area~~ shellfish growing waters will not meet the approved ~~area~~ waters classification criteria as set forth in Rule .0904 of this Section under all conditions, ~~for a reasonable period of time and the factors determining these periods are known and predictable.~~ but will meet those criteria under certain conditions;

(2) the conditions when the shellfish growing waters will meet the approved waters classification criteria are known and predictable;

(3) the public bottom within those shellfish growing waters support a population of harvestable shellfish; and

(4) staff are available to carry out the requirements defined in the management plan, as set forth in Paragraph (b) of this Rule.

(b) A written management plan shall be developed by the Division for conditionally approved areas. This plan shall define the conditions under which the shellfish growing waters may be open to the harvest of shellfish. If the conditions defined in the management plan are not met, the Division shall immediately close the shellfish growing waters to shellfish harvesting.

~~(c) When management plan criteria are met the Division may recommend to the Division of Marine Fisheries the area may be opened to shellfish harvesting on a temporary basis.~~

~~(d) When management plan criteria are no longer met or public health appears to be jeopardized, the Division will recommend to the Division of Marine Fisheries immediate closure of the area to shellfish harvesting.~~

(c) All conditionally approved growing waters shall be re-evaluated on an annual basis. A written report summarizing this re-evaluation shall be produced and shall include the following:

(1) an evaluation of compliance with management plan criteria;

(2) a review of the cooperation of all persons involved;

(3) an evaluation of bacteriological water quality in the growing waters with respect to the standards for the classification; and

(4) an evaluation of critical pollution sources.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0906 RESTRICTED AREAS

(a) ~~An area~~ Shellfish growing waters may be classified as ~~restricted~~ restricted if: ~~when a sanitary survey indicates a limited degree of pollution and the area is not contaminated to the extent that indicates that consumption of shellfish could be hazardous after controlled depuration or relaying.~~

(1) a sanitary survey indicates there are no significant point sources of pollution.

(2) levels of fecal pollution, human pathogens, or poisonous or deleterious substances are at such levels that shellstock can be made safe for human consumption by either relaying or depuration.

(b) Relaying of shellfish shall be conducted in accordance with all applicable rules, including 15A NCAC 03K and 15A NCAC ~~18A,~~ 18A .0300. ~~Rules Governing the Sanitation of Shellfish.~~

(c) Depuration of shellfish shall be conducted in accordance with all applicable rules, including 15A NCAC 03K and 15A NCAC ~~18A,~~ 18A .0300 and .0700. ~~Rules Governing the Sanitation of Shellfish.~~

(d) For shellfish growing waters classified as restricted and used as a source of shellstock for depuration, the microbiological survey, as set forth in Rule .0903 (b)(3) of this Section, indicates the bacteriological water quality does not exceed the following standards based on results generated using the systematic random sampling strategy:

(1) a median fecal coliform most probable number (MPN) or geometric mean MPN of 88 per 100 milliliters;

(2) a median fecal coliform colony-forming units (CFU) or geometric mean CFU of 88 per 100 milliliters;

(3) an estimated 90th percentile of 260 MPN per 100 milliliters for a five-tube decimal dilution test; or

(4) an estimated 90th percentile of 163 CFU per 100 milliliters for a membrane filter membrane-Thermotolerant Escherichia coli (mTEC) test.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0907 PROHIBITED ~~AREAS~~ WATERS

~~A growing area shall be classified prohibited if there is no current sanitary survey or if the sanitary survey or other monitoring program data indicate that the area does not meet the criteria as specified in approved, conditionally approved or restricted classifications. The taking of shellfish for any human food purposes from such areas shall be prohibited.~~

Shellfish growing waters shall be classified as prohibited if:

(1) no current sanitary survey, as set forth in Rule .0903 of this Section, exists for the growing area; or

(2) the sanitary survey determines:

(a) the shellfish growing waters are adjacent to a sewage treatment plant outfall or other point source outfall with public health significance.

(b) the shellfish growing waters are contaminated with fecal material, pathogenic microorganisms, poisonous or deleterious substances, or marine biotoxins that render consumption of shellfish from those growing waters hazardous.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0908 UNSURVEYED AREAS

~~Growing areas which have not been subjected to a sanitary survey shall be classified as prohibited.~~

Authority G.S. 130A-230.

15A NCAC 18A .0909 BUFFER ~~ZONE~~ ZONES

~~A prohibited area shall be established as a buffer zone around each wastewater treatment plant outfall.~~

(a) The Division of Marine Fisheries shall establish a buffer zone around the following:

(1) marinas, in accordance with Rule .0911 of this Section.

(2) wastewater treatment plant outfalls or other point source outfalls determined to be of public health significance, in accordance with the latest approved edition of the National Shellfish Sanitation Program Guide for the Control of Molluscan Shellfish, Section II: Model Ordinance, Chapter IV: Shellstock Growing Areas.

(b) Buffer zones shall be classified as prohibited.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0910 RECLASSIFICATION

~~(a) Any upward revision of an area classification shall be supported by a sanitary survey and documented in the sanitary survey report.~~

~~(b) A downward revision of an area classification may be made without a sanitary survey.~~

~~(c) When growing waters are reclassified, appropriate recommendations shall be made to the Division of Marine Fisheries regarding the opening and closure of the waters for the harvest of shellfish for human consumption.~~

Authority G.S. 130A-230.

15A NCAC 18A .0913 PUBLIC HEALTH EMERGENCY

(a) The Division of Marine Fisheries shall ~~recommend to the Division of Marine Fisheries immediate closure of~~ immediately close any potentially impacted shellfish growing waters to the harvesting of shellfish in the event of a public health emergency.

(b) The Division ~~shall recommend to the Division of Marine Fisheries re-opening~~ may re-open shellfish growing waters ~~when~~ if the condition causing the public health emergency no longer exists and shellfish have had sufficient time to purify naturally from possible contamination.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

15A NCAC 18A .0914 LABORATORY PROCEDURES

~~All laboratory examinations for water and shellfish used for the evaluation of growing areas shall be made in accordance wit~~

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~~latest approved edition by the Food and Drug Administration of "Recommended Procedures for Examination of Sea Water and Shellfish", American Public Health Association, Inc., which is adopted by reference in accordance with G.S. 150B-14(c). A copy of this publication is available for inspection at the Shellfish Sanitation Office, Marine Fisheries Building, Arendell Street, Morehead City, North Carolina 28557.~~

(a) All laboratory analyses used for the evaluation of shellfish growing areas shall be performed by a laboratory found to conform or provisionally conform to the requirements established under the National Shellfish Sanitation Program (NSSP), as determined by a Food and Drug Administration (FDA) Shellfish Laboratory Evaluation Officer or by an FDA certified State Shellfish Laboratory Evaluation Officer.

(b) All methods for the analysis of shellfish and shellfish growing waters that are used for the evaluation of shellfish growing areas shall be cited in the latest approved edition of the NSSP Guide for the Control of Molluscan Shellfish, Section IV: Guidance Documents, subsection Approved NSSP Laboratory Tests or validated for use by the NSSP under the Constitution, Bylaws and Procedures of the Interstate Shellfish Sanitation Conference. If there is an immediate or ongoing critical need for a method and no method approved for use within the NSSP exists, the following may be used:

(1) a validated Association of Analytical Communities, Bacteriological Analysis Manual, or Environmental Protection Agency method; or

(2) an Emergency Use Method as set forth in the latest approved edition of the NSSP Guide for the Control of Molluscan Shellfish.

Authority G.S. ~~130A-230;~~ 113-134; 113-182; 113-221.2; 143B-289.52.

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***Notice** is hereby given in accordance with G.S. 150B-21.3A(c)(2)g. that the Wildlife Resources Commission intends to readopt with substantive changes the rules cited as 15A NCAC 10B .0409; and 10H .1201-.1207.*

Link to agency website pursuant to G.S. 150B-19.1(c): *https://www.ncwildlife.org/Proposed-Regulations*

Proposed Effective Date: *February 1, 2021*

Public Hearing:
Date: *October 29, 2020*
Time: *6:00 pm*
Location: *Please follow this link to register for the webinar: https://ncwildlife.zoom.us/webinar/register/WN_v9T879ApQzKDtMp2wm7XKw or join by telephone: 877 853 5247 (Toll Free) or 888 788 0099 (Toll Free) Webinar ID: 970 1200 3770*

Reason for Proposed Action: *The rules in **15A NCAC 10H .1200** were part of the agency's 2016 periodic review of rules package. All rules in this Section were determined to be necessary with substantive public interest and require readoption. Because these rules have only been amended once since 1990, revisions were necessary to update language, clarify requirements and improve regulatory oversight.*
*Because of the proposed changes to the 10H .1200 rules, **15A NCAC 10B .0409** needed to be updated to align the requirements for trappers to those for fox preserve owners.*

Comments may be submitted to: *Rule-making Coordinator, 1701 Mail Service Center, Raleigh, NC 27699; email regulations@ncwildlife.org*

Comment period ends: *November 30, 2020*

Procedure for Subjecting a Proposed Rule to Legislative Review: If an objection is not resolved prior to the adoption of the rule, a person may also submit written objections to the Rules Review Commission after the adoption of the Rule. If the Rules Review Commission receives written and signed objections after the adoption of the Rule in accordance with G.S. 150B-21.3(b2) from 10 or more persons clearly requesting review by the legislature and the Rules Review Commission approves the rule, the rule will become effective as provided in G.S. 150B-21.3(b1). The Commission will receive written objections until 5:00 p.m. on the day following the day the Commission approves the rule. The Commission will receive those objections by mail, delivery service, hand delivery, or facsimile transmission. If you have any further questions concerning the submission of objections to the Commission, please call a Commission staff attorney at 919-431-3000.

Fiscal impact. Does any rule or combination of rules in this notice create an economic impact? Check all that apply.

☒ **State funds affected**
☐ **Local funds affected**
☐ **Substantial economic impact (>= $1,000,000)**
☒ **Approved by OSBM**
☐ **No fiscal note required**

CHAPTER 10 - WILDLIFE RESOURCES AND WATER SAFETY

SUBCHAPTER 10B - HUNTING AND TRAPPING

SECTION .0400 - TAGGING FURS

15A NCAC 10B .0409 SALE OF LIVE FOXES AND COYOTES TO CONTROLLED FOX HUNTING PRESERVES

(a) In counties with a trapping season for foxes and coyotes that do not prohibit live sale, ~~Licensed~~ licensed trappers may, subject to the restrictions on taking foxes in G.S. 113-291.4, live-trap foxes and coyotes during ~~any open trapping~~ that season ~~for foxes and coyotes,~~ and sell them to licensed controlled fox hunting preserves in accordance with the ~~following conditions:~~ conditions set forth in this Rule.

~~(1)~~(b) Licensed trappers are exempt from ~~caging,~~ captivity permit ~~or~~ and captivity license requirements ~~set forth in 15A NCAC 10H .0300~~ for any live-trapped foxes or coyotes trapped ~~for the~~ purpose of sale to controlled fox hunting preserves.

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N.C. Marine Fisheries Commission
2021-2022 Annual Rulemaking Cycle
Package A

November 2020

Time of Year	Action
November 2020	MFC votes on preferred management options
Nov. 2020-Jan. 2021	DMF staff drafts proposed rule options
February 2021	MFC votes on preferred option for proposed rules
February-April 2021	Fiscal analysis of rules prepared by DMF staff and approved by Office of State Budget and Management
May 2021	MFC approves Notice of Text for Rulemaking
August 2021	Publication of proposed rules in the *North Carolina Register*
August-October 2021	Public comment period held
September 2021	Public hearing(s) held (details to be determined)
November 2021	MFC considers approval of permanent rules *
January 2022	Rules reviewed by Office of Administrative Hearings/ Rules Review Commission
April 1, 2022 *or* TBD	Proposed effective date of rules unless rules are subject to legislative review per S.L. 2019-198 and G.S. 14-4.1.
April 1, 2022	Rulebook supplement available online
April 15, 2022	Commercial license sales begin

* 15A NCAC 03 readoption deadline of June 30, 2022 for final MFC approval

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N.C. Marine Fisheries Commission
2021-2022 Annual Rulemaking Cycle
Package B

November 2020

Time of Year	Action
November 2020	MFC votes on preferred management options
Nov. 2020-Jan. 2021	DMF staff drafts proposed rule options
February 2021	MFC votes on preferred option for proposed rules
February-July 2021	Fiscal analysis of rules prepared by DMF staff and approved by Office of State Budget and Management
August 2021	MFC approves Notice of Text for Rulemaking
October 2021	Publication of proposed rules in the *North Carolina Register*
Oct.-Nov. 2021	Public comment period held
October 2021	Public hearing(s) held (details to be determined)
February 2022	MFC considers approval of permanent rules *
April 2022	Rules reviewed by Office of Administrative Hearings/ Rules Review Commission
April 15, 2022	Commercial license sales begin
May 1, 2022 *or* TBD	Proposed effective date of rules unless rules are subject to legislative review per S.L. 2019-198 and G.S. 14-4.1.
May 1, 2022	Rulebook supplement available online

* 15A NCAC 03 readoption deadline of June 30, 2022 for final MFC approval

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RULE SUSPENSIONS

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ROY COOPER
Governor
MICHAEL S. REGAN
Secretary
STEPHEN W. MURPHEY
Director

October 23, 2020

MEMORANDUM

TO: N.C. Marine Fisheries Commission

FROM: Kathy Rawls, Fisheries Management Section Chief

SUBJECT: Temporary Rule Suspension

Issue
In accordance with the North Carolina Division of Marine Fisheries Resource Management Policy Number 2014-2, Temporary Rule Suspension, the North Carolina Marine Fisheries Commission will vote on any new rule suspensions that have occurred since the last meeting of the commission.

Findings
The suspension of North Carolina Marine Fisheries Commission Rule 15A NCAC 03M .0301 (b)(2) and (3)(A)(B) King Mackerel, occurred since the August 2020 meeting, is subject to commission approval and is noted as an action item on the agenda.

Action Needed
The commission is scheduled to vote on approval of the continued suspension of portions of rule 15A NCAC 03M .0301.

Overview
The following rule suspension occurred since the August 2020 meeting and in accordance with policy is subject to approval and is noted as an action item on the agenda:

NCMFC RULE 15A NCAC 03M .0301 (b)(2) and (3)(A)(B) King Mackerel

Suspension of portions of this rule is for a time certain. This rule suspension allows the division to increase the recreational possession limit of King Mackerel in accordance with action taken by the South Atlantic Fishery Management Council to address economic losses to the recreational fishing communities and industries. This suspension was implemented in Proclamation FF-37-2020 and will expire at 11:59 P.M. on March 16, 2021.

In accordance with policy, the division will report current rule suspensions previously approved by the commission as non-action, items. The current rule suspensions previously approved by the commission are as follows:

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NCMFC RULE 15A NCAC 03M .0511 Bluefish

Suspension of this rule is for an indefinite period. Suspension of this rule allows the division to reduce bluefish creel limits in compliance with the requirements of the Mid-Atlantic Fishery Management Council/Atlantic States Marine Fisheries Commission Bluefish Fishery Management Plan to reduce recreational harvest of bluefish. This suspension was implemented in Proclamation FF-1-2020.

NCMFC Rule 15A NCAC 03J .0103 (h) Gill Nets, Seines, Identification, Restrictions

Suspension of portion of this rule is for an indefinite period. Suspension of this rule allows the division to implement year around small mesh gill net attendance requirements in certain areas of the Tar, Pamlico and Neuse River systems. This action was taken as part of a department initiative to review existing small mesh gill net rules to limit yardage and address attendance requirements in certain "hot spot" areas of the state. This suspension continues in Proclamation M-12-2020.

NCMFC Rule 15A NCAC 03R .0110 (4)(5) Crab Spawning Sanctuaries

Suspension of portions of this rule is for an indefinite period. Suspension of this rule allows the division to revise the boundaries for the Drum Inlet and Barden Inlet crab spawning sanctuaries in accordance with Amendment 3 to the N.C. Blue Crab Fishery Management Plan. This suspension was implemented in Proclamation M-7-2020.

NCMFC Rules 15A NCAC 03L .0201 (a)(b) Crab Harvest Restrictions, 03L .0203 (a) Crab Dredging and 03J .0301 (g)(h) Pots

Suspension of portions of these rules is for an indefinite period. Suspension of these rules allows the division to implement requirements for the blue crab fishery in accordance with Amendment 3 to the N.C. Blue Crab Fishery Management Plan. These suspensions were implemented in Proclamation M-8-2020.

NCMFC Rule 15A NCAC 03L .0103 (a)(1) Prohibited Nets, Mesh Lengths and Areas

Continued suspension of portions of this rule is for an indefinite period. This allows the division to adjust trawl net minimum mesh size requirements in accordance with the May 2018 Revision to Amendment 1 to the North Carolina Shrimp Fishery Management Plan. This suspension was implemented in proclamation SH-3-2019.

NCMFC 15A NCAC 03M .0516 Cobia

Continued suspension of this rule is for an indefinite period. This allows the division to manage the commercial and recreational cobia fisheries in accordance with management actions taken by the commission and in accordance with the Atlantic States Marine Fisheries Commission's Interstate Cobia Fishery Management Plan. This suspension was continued in Proclamation FF-15-2020.

NCMFC Rule 15A NCAC 03J .0501 Definitions and Standards for Pound Nets and Pound Net Sets

Continued suspension of portions of this rule is for an indefinite period. This allows the division to increase the minimum mesh size of escape panels for flounder pound nets in accordance with Amendment 2 of the North Carolina Southern Flounder Fishery Management Plan. This suspension was implemented in Proclamation M-34-2015.

NCMFC Rule 15A NCAC 03M .0519 Shad & 03Q .0107 Special Regulations: Joint Waters

Continued suspension of portions of these rules is for an indefinite period. This allows the division to change the season and creel limit for American shad under the management framework of the North Carolina American Shad Sustainable Fishery Plan. These suspensions were continued in Proclamation FF-55-2019.